GRIT AND BELIEFS ABOUT INTELLIGENCE: THE RELATIONSHIP AND ROLE THESE FACTORS PLAY IN THE SELF-REGULATORY PROCESSES INVOLVED IN MEDICAL STUDENTS LEARNING GROSS ANATOMY

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GRIT AND BELIEFS ABOUT INTELLIGENCE: THE RELATIONSHIP AND ROLE THESE FACTORS PLAY IN THE SELF-REGULATORY PROCESSES INVOLVED IN MEDICAL STUDENTS LEARNING GROSS ANATOMY

Background: Gross anatomy is a foundational medical school course upon which other courses and patient care is grounded; however, variability in student performance suggests potential in studying underlying non-academic factors to explain some of these inconsistencies. Thus, this study examined medical students' implicit theories of intelligence (ITI) and grit in order to better understand student learning outcomes in gross anatomy.

Methods: A mixed methods study was conducted using 2nd, 3rd, and 4th year medical students who successfully completed gross anatomy. Students (n=382) completed the ITI Scale and Short Grit Scale in order to identify individual's ITI and grit scores. Subsequent interviews (n=25) were conducted to explore how medical students set goals, operated while reaching those goals, and monitored their progress in achieving those goals.

Results: Entity and incremental theorists with high grit performed significantly better in gross anatomy when compared to those with low grit. Further, highly gritty incremental and entity theorists were hard workers and showed resilience in the face of challenges. Specifically, those with an entity ITI had the central goal of getting an honors grade, while those with an incremental ITI desired to understand and apply their anatomical knowledge. Conversely, low grit individuals became overwhelmed by challenges, were more likely to show an inconsistent work ethic, and questioned their ability to master the material. An individual's ITI, more so than grit, drove the presence of negative emotions in a medical student, with entity theorists feeling anxious and vulnerable, and incremental theorists feeling fewer negative emotions. Finally, grit level moderated how a medical student would respond to negative emotions, with highly gritty individuals exhibiting more constructive coping mechanisms.

Conclusions: These findings suggest that medical students who possess high grit and an incremental theory of intelligence have the most effective learning strategies, set achievable goals, and enlist effective coping mechanisms while learning gross anatomy. The findings and tools used in this study could be incorporated into the medical school admissions process. Finally, findings reinforce the value of examining the ITI and grit of medical students, as they can provide educators with insight regarding important non-academic factors driving learning in gross anatomy.

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LIST OF ABBREVIATIONS

IUSM: Indiana University School of Medicine

ITI: Implicit Theories of Intelligence

E: Entity Theorist

I: Incremental Theorist

HG: High Grit

LG: Low Grit

HE: Individuals who are entity theorists with a high grit score

HI: Individuals who are incremental theorists with a high grit score

LE: Individuals who are entity theorists with a low grit score

LI: Individuals who are incremental theorists with a low grit score

CHAPTER 1: INTRODUCTION

Gross Anatomy is a foundational course typically taken during the first semester of medical school matriculation. It establishes the knowledge base upon which many other courses and future patient care is grounded (Pabst, Nave, Rothkotter, & Tschernig, 2001; Sugand, Abrahams, & Khurana, 2010). In surveying trained physicians, research has shown that the majority considers anatomy to have been a course that was highly relevant in their training to become a physician (Pabst & Rothkotter, 1997); training that aims to produce physicians with the knowledge, skills, and attitudes necessary to address the health needs of the populations they serve. Yet, over the past two decades the teaching of anatomy to medical students has undergone major transformative changes; changes that some believe are having "an adverse effect on the level of anatomical knowledge," higher order understanding, and long-term anatomical knowledge retention of medical graduates (Collins, Gien, Hulsebosch & Miller, 1994; Pandey & Zimitat, 2007, p. 7). These changes include, but are not limited to: (1) a decline in the number of qualified anatomy teachers (Cahill and Leonard, 1999; Cahill, Leonard, & Marks, 2000; Older, 2004); (2) the absence of a core anatomy curriculum (Halasz, 1999; Older, 2004; Raftery, 2007); (3) a decreased use of dissection as a teaching tool (Cahill et al., 2000; Reidenberg & Laitman, 2002; Raftery, 2007); (4) a lack of anatomy taught in a broader medical context (Reidenberg & Laitman, 2002; Raftery, 2007; Norman, et al., 2007); (5) the rise of integrated curricula (Monkhouse & Farrell, 1999; Williams & Lau, 2004); (6) an inadequate assessment of anatomical knowledge (Raftery, 2007; Turney, 2007); (7) a decrease in anatomy teaching time (Drake, 1998; McCuskey, Carmichael, & Kirch, 2005); and (8) a failure to vertically integrate anatomical teaching (McCrorie, 2001;

Older, 2004; Norman et al., 2007; Bergman, Prince, Drukker, van der Vleuten, & Scherpbier, 2008; Yammine, 2014).

The deficiency in anatomical knowledge, or competence, that these changes are causing only becomes more problematic in light of the fact that there is no clear consensus on the minimal amount of anatomical knowledge that students should possess at the end of medical school (Bergman et al., 2008). Yet, from the beginning of medical school, students striving to become future doctors want knowledge, need knowledge, aim for knowledge, and maintain a fundamental desire to acquire and exercise knowledge in their developing craft. Its acquisition is readily sought after, inherently sustained, generously rewarded, and eventually becomes a way in which to measure one's self, and by which others do their measuring.

It is helpful, therefore, to consider the factors that drive the successful development of anatomical knowledge. However, our understanding of how medical students initially begin to develop their anatomical knowledge is fragmented. While numerous studies have examined common deficiencies seen in anatomical knowledge, current anatomical teaching methodologies, and the ways in which anatomical knowledge is assessed, there are no studies this researcher is aware of that have explored gross anatomy and the conceptualization of intelligence (the beliefs one holds pertaining to intelligence); more specifically, no studies have examined the relationships between learning gross anatomy, the conceptualization of intelligence, and the non-academic trait termed, grit (Pabst & Rothkotter, 1997; Garg, Norman, & Sperotable, 2001; Pandey & Zimitat, 2007; Wilhelmsson et al., 2010; Wilhelmsson, Dahlgren, Hult, & Josephson, 2011).

The non-academic term, grit, was first introduced by Duckworth and colleagues to describe the attitude or manner of an individual participating in an arduous endeavor (2007). It can be defined as the "perseverance and passion for long-term goals," and "entails working strenuously toward challenges, maintaining effort and interest over years despite failure, adversity, and plateaus in progress" (Duckworth, Peterson, Matthews, & Kelly, 2007, p. 1088). It is the gritty individual that "approaches achievement as a marathon; his or her advantage is stamina" (Duckworth et al., 2007, p. 1088). In addition, grit has been found to be a superior predictor of success in several high achievement, high stress fields, above and beyond that explained by IQ. When measured, grit can quantify the ability of an individual to maintain sustained effort throughout an extended length of time—for example, the time it takes to become a competent physician (Duckworth et al., 2007).

A need therefore exists to study the development of anatomical competence from a different perspective; a perspective that examines the relationships between the perspectives and beliefs medical students hold on intelligence (the conceptualization of intelligence), their grittiness, and the impact these variables have on the self-regulatory processes involved in learning gross anatomy. This approach is uniquely powerful, precisely because learning behaviors are directly influenced by an individual's beliefs, and such beliefs about one's intelligence influences how students learn.

The beliefs an individual holds with respect to intelligence can be understood through using a social cognitive model called self-theories of intelligence; self-theories of intelligence are a set of theories that provide a way to view intelligence, explains variations in learning behaviors, and has the potential to better our understanding of the inconsistencies in anatomical knowledge that medical students are entering residency with. The major self-theories of intelligence used in social cognitive research consist of two separate theories, offering two ways to explain how people in general view their personal attribute of intelligence; namely, do they believe their intelligence is fixed (reflective of those holding an *entity theory* of intelligence), or do they believe intelligence to be malleable (reflective of those holding an *incremental theory* of intelligence) (Pintrich, 2002)?

Though how an individual views or defines intelligence is often not explicitly articulated, these theories are commonly referred to as one's implicit theory of intelligence (Teunissen & Bok, 2013). Once again, self-theories of intelligence, referred to as implicit theories of intelligence (ITI) henceforth, are the beliefs individuals hold about the fixedness or malleability of intelligence; those believing intelligence is a fixed trait are said to hold an *entity* theory of intelligence. While those believing intelligence is a malleable quality are said to hold an *incremental* theory of intelligence. Entity theorists hold that intelligence is a concrete entity, that "one either has the ability to perform successfully in a certain task or one doesn't" (Tuenissen & Bok, 2013, p. 1065). In contrast, incremental theorists believe intelligence is malleable and something that can "be developed or cultivated through effort" (Tuenissen & Bok, 2013, p. 1065).

Approximately 20% of the population in North America fit into a hybrid group that consists of individuals holding both entity and incremental beliefs, with the remainder of the population equally split between the two beliefs—half are entity theorists, and half are incremental theorists (Dweck & Grant, 2008). It is important to note, however, that ITI can be subject-specific, even for the same individual; that is, one individual may hold an incremental theory of intelligence for one particular subject (i.e. math), but hold an entity theory of intelligence for another subject matter (i.e. music). Now, in the context of medical education, specifically anatomy, these two theories can be thought of as separate ends of a continuum. A continuum that reflects the fact that medical students often differ in a key way, namely in the extent to which they believe that their intelligence is fixed versus malleable; so, "although two people may be similar in intellectual aptitude, their beliefs about the malleability of intelligence may differ, resulting in differences in their academic performance and subsequent motivation" (Shively & Ryan, 2013, p. 242).

Research has yet to examine how medical students' views on intelligence (ITI) and grittiness impact their self-regulatory processes involved in learning gross anatomy. For this study, self-regulation is "the sense of purposive processes, the sense that self-corrective adjustments are taking place as needed to stay on track for the purpose being served, and the sense that the corrective adjustments originate within the person" (Carver & Scheier, 2010, p. 3). Furthermore, from Carver and Scheier's (1998) self-control theory, self-regulation in learning is conceptualized as three core processes: goal setting, goal operating, and goal monitoring.

The self-regulatory processes of goal setting, goal operating, and goal monitoring are actions that medical students find themselves constantly doing. These actions are generally done with purpose, are proactively self-corrected as needed, and are maintained in order to reach a desired goal—in this case competently learning gross anatomy. While some studies have shown null effects (Biddle, Wang, Chatzisarantis, & Spray, 2003; Ommundsen, Haugen, & Lund, 2005; Doron, Stephan, Boiche, & Le Scanff, 2009), many others have demonstrated that implicit theories of intelligence (ITI) are related to, and can predict an array of self-regulatory processes (Thompson & Musket, 2005; Molden & Dweck, 2006; Kray & Haselhuhn, 2007; Nussbaum & Dweck, 2008). For example, it is hypothesized that incremental theorists typically set goals that are focused on deep learning, they employ mastery-oriented strategies in order to reach these goals, and typically report greater feelings of confidence and expectations when evaluating the potential for goal success (Molden & Dweck, 2006). Conversely, it has been hypothesized that entity theorists typically set goals that are focused on successful performance, they employ helpless-oriented strategies in response to challenges, and typically report feelings of anxiousness and vulnerability when reflecting upon their performance (Nussbaum & Dweck, 2008).

In addition, the self-regulatory processes of goal setting, goal operating, and goal monitoring are influenced by an individual's grittiness. Grittier individuals have a tendency to maintain focused interest, show sustained effort, and are less likely to quit the task at hand (Eskreis-Winkler, Duckworth, Shulman, & Beal, 2014). However, in the context of medical students learning anatomy, we do not fully understand ITI, grit, or the key moderators between students' ITI, grit, and the self-regulatory processes that impact learning. In chapter two, these self-regulatory processes are further discussed in more detail within the context of implicit theories of intelligence and grit.

Because an individual's personally held implicit theory of intelligence (ITI), and level of grittiness influences their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning, great potential therefore exists for better understanding the complex acquisition of anatomical knowledge by medical students.

This in part, is due to the fact that one's ITI and grittiness have the capacity to create an unseen infrastructure of meaning and understanding that shape the interpretation of events and experiences, guide cognition, drive behavior, and determine important academic outcomes. Examining the perspectives medical students hold on intelligence, their level of grittiness, and the impact these elements have on their self-regulatory processes, will have broad implications in the field of medical education and the learning of anatomy. This is particularly important as the teaching of anatomy undergoes transformation within the evolving landscape of medical school curriculum, a transformation that is arguably impacting the knowledge, preparation, and ability of residents to apply their formal anatomical knowledge to clinical practice. As such, understanding the interactions among ITI, grit, and the goal setting, operating, and monitoring of medical students involved in the anatomical learning environment will become ever more crucial.

Statement of Problem

Medical students are under intensifying pressure in the medical school environment as a result of several elements, or factors within that environment. These have direct implications in the field of anatomical education. Four such changing factors (intellectual, infrastructural, methodological, and scope-of-focus) are described here.

Intellectual Changes

First, are intellectual changes. Over the past two decades the teaching of anatomy to undergraduate medical students has undergone major transformative changes. These changes are in part attributable to the fact that the required knowledge base for medical practice is expanding to unprecedented, overloaded levels, encompassing ever-increasing amounts of information (Horowitz, Gramling & Quill, 2014). With the delivery of patient care becoming vastly more complicated, medical schools must respond to this changing landscape, shouldering the task of competently and practically preparing physicians for the 21st century.

Amid these changes, the aim of undergraduate medical education continues to be to prepare medical students for supervised professional practice (i.e., internship or residency training). However, as the required knowledge base for medical practice has grown, numerous educational bodies, foundations, and professional task forces including the Association of American Medical Colleges (AAMC), The Commonwealth Fund, the Institute of Medicine, and the Carnegie Foundation for the Advancement of Teaching, have criticized the preparation of this phase of the medical education continuum. These groups criticize "medical education for emphasizing scientific knowledge over biologic understanding, clinical reasoning (and) practical skill" (Cox & Irby, 2006, p. 1339). Additional anatomy-specific literature suggests that "undergraduate medical students and recent graduates feel inadequately prepared to use their anatomical knowledge in the clinic," citing one case where only 14% of final year students felt confident in their anatomical knowledge (Norman, 2005; Bhangu, Boutefnouchet, Yong, Abrahams, & Joplin, 2010; Lazarus, Chinchilli, Leong, & Kauffman, 2012, p. 188). Some have even suggested that there is an anatomical ignorance and "emerging culture among junior students who are unsure of their capacity for competent practice," attributable to modern courses and pre-clinical studies that are too intense (Mitchell & Batty, 2009, p. 118).

Infrastructural Changes

Second, another factor contributing to the challenging medical school environment, are infrastructural changes. Due to the dramatic growth in size and complexity of medical schools over the last century, curricular changes have included the integration of disciplines, decrease in student contact time, condensed anatomy curriculum, and the increased use of systems-based approaches when teaching this foundational science (Barchi & Lowery, 2000; Louw, Eizenberg & Carmichael, 2009; Pandey & Zimitat, 2007). Material factors like budget cuts and the emergence of new technologies have seen that the "teaching of anatomy is involving less dissection and greater use of prosected and plastinated specimens, fewer lectures, more tutorials…and the use of web-based and computer-based resources," which some argue may be having a detrimental effect on anatomical understanding (Pandey & Zimitat, 2007, p. 7). Decreased curriculum time has also meant a "greater reliance on student-directed learning (SDL), and a reconsideration of how cadavers, computer-based simulation and other approaches might best be deployed" (Regan de Bere & Mattick, 2010, p. 573). That is to say, the infrastructure medical students are now required to work within can arguably lead to an environment where "the formal knowledge foundational to medical practice is not well integrated with the acquisition of experiential knowledge over the continuum of medical education" (Cooke, Irby, & O'Brian, 2010, p. 28).

Methodological Changes

A third factor contributing to the challenging medical school environment are methodological changes. Due to novel developments in teaching, the unique role, identity, and methods used in anatomical education have evolved. As some practitioners and educators in the field have pointed out, “the future of medical education is no longer blood and guts, it’s bits and bytes,” and medical students are more than ever “trading cuts for clicks” when learning anatomy (Gorman, Andreas, & Rawn, 2000, p. 353). While many medical schools maintain the traditional cadaveric dissection, several others have begun to integrate innovative methods into the teaching of gross anatomy, using methodologies that are as numerous as they are different. These include but are not limited to: the implementation of problem-based (PBL) or team-based learning (TBL), the use of computer-based simulations, a focus on self-directed student learning, the reliance upon 3-D virtual reality programs over traditional cadaveric dissection, and perhaps most notably, an increase in the proportion of clinically focused skills-based anatomy courses.

Scope-of-Focus Changes

Fourthly, scope-of-focus changes are another factor contributing to the challenging medical school environment. Scope-of-focus changes can be seen in the increased push to emphasize teaching clinically relevant anatomy in recent years; a push lauded by many as a necessary progression that ensures the relevance of anatomy in contemporary medical contexts, future patient care, and in the application of the science in clinical settings (Regan de Bere & Mattick, 2010; Ahmed et al., 2010). This focus on clinically relevant anatomy has led to a positive increase in the use of “relevant surface, clinical and radiological approaches to identifying anatomical structures and pathologies” (Regan de Bere & Mattick, 2010, p. 574). However, it has also led to disagreements about what comprises essential knowledge in anatomical education (McLachlan and Regan de Bere, 2004; Patten 2007), especially as things are beginning to shift from “a focus on facts and details to a focus on general principles, mechanisms and concepts" in anatomy (Bergman, Verheijen, Scherpbier, Van der Vleuten, & De Bruin, 2014, p. 296). For many academic anatomists, anatomy is viewed as an extensive factual knowledge base to be learned in its entirety, and that sacrificing any of the depth and breadth of anatomical content in exchange for clinical application and correlation is a mistake (Older, 2004). This depth and breadth is essential, for "operating without a firm knowledge of extensive anatomy leads directly to increased morbidity and mortality because patients are kept on the operating table too long while residents struggle in difficulty with the anatomy" (Marks & Cahill, 1988, p. 3).

While anatomy is only part of the first two years of a students' undergraduate medical education, the impact of these evolving intellectual, infrastructural, methodological, and focal changes on this foundational basic science are not entirely understood and need further investigation. The acuity of this need is made manifest by recent findings of Bergman and colleagues (2014). They reviewed 32 articles published after 1990, and identified eight factors that have been cited in the literature as having been contributors to the decline of anatomical knowledge; factors that people credit for the decline in anatomical knowledge. These factors were: (1) teaching by nonmedically qualified teachers, (2) the absence of a national core anatomy curriculum, (3) a decreased use of dissection as a teaching tool, (4) lack of anatomy in context, (5) integrated curricula, (6) inadequate assessment of anatomical knowledge, (7) decreased anatomy teaching time, and (8) neglect of vertical integration of anatomy teaching within the medical curriculum (Bergman et al., 2014). However, Bergman and colleagues found that the evidence in support of these factors playing significant roles in the decline of anatomical knowledge was lacking, and they recommended that "further research on the implementation of teaching in context, vertical integration, and assessment strategies" be conducted (Bergman et al., 2014, p. 301).

So, how do we reconcile the findings of Bergman and colleagues, with the views of many teachers, researchers, and educators that today's incoming residents are not as prepared as they should be, or could be, with respect to their anatomical knowledge, competence, and ability to apply their knowledge (Balla, 1990; Cottam, 1999; Fitzgerald, White, Tang, Maxwell-Armstrong & James, 2008; Lazarus et al., 2012)? It is important to note that nobody is arguing that the feelings of many teachers, researchers, and educators spontaneously arose and reflect disingenuous concerns; these feelings are based on perceptions and experiences with residents and students in the medical school environment. However, the apparent lack of empirical evidence clearly shows how these factors are, in actuality, adversely impacting the field of anatomy, and make it difficult for medical students and medical educators alike to identify the most effective ways to teach and learn anatomy in order to ensure competence. Thus, examining medical students' ITI and grit in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy offers a novel approach to ascertaining the impact these changes are having, if any.

While anatomical education research encompass a wide array of subjects, the recent trend leans heavily towards practical methods of how to teach anatomy and assessments of outcomes. This worthy, yet at times, myopic pursuit of compartmentalizing problems and solutions, largely ignores the potential role ITI and grit play in medical student learning and professional success. As such, this study addresses a gap in the literature, as it seeks to understand the relationship between student conceptualization of intelligence, grittiness, and the self-regulatory processes students use as they navigate the ever-evolving field of anatomical education within medical school.

Purpose of the Study

To address this gap in the literature, the purpose of this study was to investigate three interrelated concepts as questions: (1) how do medical students view intelligence?; (2) how gritty are medical students?; and (3) how do medical students' views of intelligence and level of grit impact goal setting, goal operating, and goal monitoring in anatomy?

It is clear that within the medical domain a central component of physician competence is functional knowledge of anatomy, a foundation of the medicine they practice. How this lack of anatomical knowledge can be addressed and remedied before it becomes a problem in residency is however not so clear. While research has shown that learning is often undermined when a fixed conceptualization of intelligence is adopted, we have yet to understand how grit and beliefs about intelligence in anatomy practically impact the goal setting, goal operating, and goal monitoring behaviors of medical students in anatomy (Stipek & Gralinsky, 1996; Hong, Chiu, Dweck, Lin, & Wan, 1999; Leondari & Gialamas, 2002; Ommundsen, 2003).

Research Question

The main purpose of this study was to examine the structure of medical students' implicit theories of intelligence (ITI), level of grit, and to explore the relationship between ITI, grittiness, and the goal setting, goal operating, and goal monitoring of these individuals in the process of learning gross anatomy. Few studies discuss ITI in the realm of medical education; none are specific to anatomy, and no studies have explored the links among ITI, grit, and the self-regulatory behaviors embedded in learning anatomy. Therefore, this study was guided by the following research question: What are the relationships between medical students' beliefs about intelligence and grittiness in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy?

Finally, understanding the ITI of medical students is a neglected area of medical education research, and formally assessing the grittiness of medical students has yet to be explored. Nevertheless, both are important mediators of student development and subsequent achievement. Understanding the interplay between the ITI held by medical students, their grittiness, and their goal setting, goal operating, and goal monitoring within the context of gross anatomy, will enhance our understanding of the anatomical learning gaps seen in medical students.

Significance

This study focuses on the views of intelligence that medical students hold, their grittiness, and the self-regulatory processes involved in learning gross anatomy. As such, it has implications in three areas: the gross anatomy classroom, the field of medical education, and curricular reform in medical school.

Gross Anatomy Classroom

Previous studies illustrate that the medical gross anatomy classroom is changing (Cottam, 1999; Waterston & Stewart, 2005; Pandey & Zimitat, 2007). In the context of these changes, medical education still aims to "transmit the knowledge, impart the skills, and inculcate the values of the profession in an appropriately balanced and integrated manner" (Cooke et al., 2006, p. 1341). However, the final and most important test for our medical students, residents, and even practicing physicians, will be using what they know in order to practice that craft effectively and competently. Understanding the ITI and grittiness of our medical students will inform our understanding of the goal setting, goal operating, and goal monitoring these individuals employ and how these self-regulatory behaviors impact their learning in the classroom and clinic. As such, these findings have the potential to help learners become aware of the factors that drive their learning. In particular it can illustrate how the presence of grit can help individuals develop into those that "welcome the challenge to confront and overcome obstacles," and when more is required of them, summon "their resources and apply themselves to the task at hand," resulting in a much higher level of performance in the end (Dweck, 2000, p. 10). Understanding medical student goals, behaviors, and learning processes through the lens of ITI and grit will illuminate how theory-based meaning systems either support or hinder learning in anatomy.

Field of Medical Education

The second area of implications for this work is in the broader field of medical education. Calls in medical education are stronger than ever to help learners develop into competent physicians (Kalet & Pusic, 2014). Using ITI and grittiness as a conduit to understand the gaps where medical education is still falling short is a novel approach in the field; a welcome approach as evidence points to a wide range of skill deficits and "a gap between what program directors expect and the baseline competence" of our recent medical school graduates (Lypson, Frohna, Gruppen, & Woolliscroft, 2004, p. 569). Program directors confirm that their early (post graduate year one) residents are often unprepared to perform basic tasks (Langdale et al., 2003). Lypson et al. (2004) points out that,

> Once in their GME [graduate medical education] programs, residents too often point out that they were told as medical students that certain skills or processes would be learned when they became residents; but once they became residents, they were expected to have learned them in medical school. (p. 565)

Given these issues, identifying the patterns where ITI and grit work together in the medical school environment with constructive goal setting, operating, and monitoring could provide explanation and a framework for how one might best address these gaps in performance before students begin their residency.

Curricular Reform

The third area of implications for this study is situated in current issues surrounding curricular reform in medical schools. The majority of medical schools across the United States structure their curriculum into two phases, commonly referred to as the medical disciplines model, or discipline-based curriculum structure—two years of coursework, followed by two years of clinical rotations (Cooke et al., 2010). Conversely, some medical schools have implemented, with varying levels of success, an integrated organ systems based model to teach their students; this approach aims to integrate coursework and clinical sciences from the beginning, organizing the material around body systems (Cooke et al., 2010). There are countless variations, both large and small, on the aforementioned curricular formats, and likely as many arguments put forth over the superiority of one particular curricular platform over another (Barchi & Lowery, 2000; Pandey & Zimitat, 2007; Louw et al., 2009).

While researching the effectiveness of different curricula is beyond the scope of this study, there is a need to help our future physicians in the balancing act of delivering high quality care, and the "requirement to continuously learn from practice," regardless of the curricular format they experience in medical school (Teunissen & Bok, 2013, p. 1070). The charge to continually learn from practice is a careful balancing act that requires grit, or in other words, a perseverance towards the integration of performance goals (entity theory based) with learning goals (incremental theory based) as one establishes their intellectual foundation in medicine (Teunissen & Bok, 2013). A balancing act that deserves assistance from our medical educators and a more explicit place in the undergraduate curriculum; a place, that in better understanding the ITI and grittiness of our medical students, can most effectively be carved out.

Study Design

In asking what the relationships are between medical students' beliefs about intelligence and grittiness in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy, the researcher used a two-phase sequential explanatory mixed methods case study design for data collection and analysis. Using a social cognitive model of motivation, called implicit theories of intelligence (ITI), and the concept of grit, this study attempted to understand the self-regulatory processes of goal setting, goal operating, and goal monitoring of medical students and how these factors impact learning in gross anatomy. To do this, data were collected in two phases—a quantitative data collection phase and a qualitative data collection phase. The quantitative data collection, or phase one, consisted of having medical students, who have completed their gross anatomy requirement, complete the

Implicit Theory of Intelligence Scale (ITIS) survey, and the Short Grit Scale survey in order to identify the structure of their implicit theory of intelligence and grit score, respectively. The ITIS survey was developed by Carol Dweck (2000), and identified and assessed the degree to which participants consider intelligence fixed or malleable. Conversely, the Short Grit Scale was first modeled by Duckworth and colleagues (2007), and quantitatively measured the perseverance and passion, or grittiness, that an individual has for long-term goals. The qualitative data collection, or phase two, consisted of one-on-one, in-depth, semi-structured interviews. Participants were asked about their goal setting, goal operating, and goal monitoring processes they used while learning gross anatomy.

Definition of Terms

Implicit Theories of Intelligence (ITI): Implicit theories of intelligence (ITI) essentially encompass the ways in which individuals think of their own personal attributes; of particular interest to this study, intelligence. "Mastery-oriented qualities grow out of the way people understand intelligence and there are two entirely different ways that people understand intelligence," including an entity theory of intelligence and an incremental theory of intelligence (Dweck, 2000, p.2). If an individual believes that intelligence is a fixed, unchanging, or static personal trait, it is said that they hold an *entity theory* of intelligence; this is "because intelligence is portrayed as an entity that dwells within us and that we can't change (it)" (Dweck, 2000, p. 2). Conversely, if an individual believes that intelligence is a malleable, changing personal trait to be "cultivated through learning," it is said that they hold an *incremental theory* of intelligence; this is because “intelligence is portrayed as something that can be increased through one’s efforts” (Dweck, 2000, p. 3).

Grit: Grit is defined in this context according to Duckworth and colleagues as “the perseverance and passion for long-term goals” and entails not only working hard and consistently towards challenges, but “maintaining effort and interest [towards one’s goals] over years despite failure, adversity and plateaus in progress” (Duckworth et al., 2007, p. 1087). In addition, the gritty individual is one who “approaches achievement as a marathon; his or her advantage is stamina…the gritty individual stays the course” (Duckworth et al., 2007, p. 1088).

Self-Regulation: Self-regulation can be generally understood as the actions of an individual, done with purpose, that are proactively self-corrected when need be, in order to attain a desired goal. For the purposes of this study, self-regulation is conceptualized in terms of three crucial processes that impact the learning of gross anatomy in medical school (Carver & Scheier, 2010, p. 3). These core processes underlay self-regulation as established by Carver and Scheier’s (1998) self-control theory and are: goal setting, goal operating, and goal monitoring. It has been shown that implicit theories of intelligence (ITI) predict and are related to a number of self-regulatory processes—although the strength and the direction of this effect are still debated (Biddle et al., 2003; Thompson & Musket, 2005; Molden & Dweck, 2006; Kray & Haselhuhn, 2007; Nussbaum & Dweck, 2008).

Goal Setting: Goal setting is the act of an individual in establishing specific reference points, or end states for a particular situation (Carver & Scheier, 1982; Moskowitz & Grant, 2009). In context of ITI, beliefs about the malleability versus fixedness of intelligence often influence and determine the types of goals that an individual sets; with entity theorists often setting performance-oriented goals, and incremental theorists often setting learning-oriented goals. In addition, individuals that are highly gritty will deliberately set long-term goals and objectives, persistently working at them, even in the absence of positive feedback.

Goal Operating: Goal operating is the actions, behaviors, and activities of an individual that are directed towards, and with respect to, achieving one's personal goals (Carver & Scheier, 1998). With respect to ITI, there are two major ways in which individuals often react to setbacks as they attempt to reach a particular goal. These are with helpless-oriented responses (seen with entity theorists), which are characterized by a sense of distancing one's self from problems that arise, failing to assume responsibility for failure, and a sense of giving up when difficulty arises. Conversely, mastery-oriented responses (seen with incremental theorists), are responses characterized by assuming responsibility for failure as well as success, and individuals display a sense of increased dedication and hard work when setbacks or difficulties arise.

Goal Monitoring: Goal monitoring is the examination, and consideration of how one's goals, and the operating mechanisms they have used (helpless vs. mastery-oriented responses) to reach that goal, are helping or hindering their progress towards their desired achievement. Monitoring how one's goal is progressing is often reflective of the ITI one holds, and their level of grittiness. Entity theorists and those with lower levels of grit are more often linked with greater negative emotions of helplessness and anxiety when a goal is not met, or failure is experienced. While incremental theorists and those individuals with more grit are often linked with greater, more optimistic expectations of how their goals are progressing, regardless of failures along the way (Biddle et al., 2003; Thompson & Musket, 2005; Molden & Dweck, 2006).

Dissertation Overview

This study focused on understanding the relationships between medical students' beliefs about intelligence and grittiness in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy, and has broad implications for curriculum, understanding individual motives in learning in the evolving anatomy classroom, and addressing anatomical knowledge gaps. In the subsequent chapters, I review relevant literature on the changing anatomical landscape in medical schools, implicit theories of intelligence, and grit. In addition, I will provide a methodology for studying and examining medical students' implicit theories of intelligence, grit, and how these theories relate to goal setting, goal operating, and goal monitoring in learning gross anatomy. And finally, results from the study, as well as discussion and conclusions are put forward.

CHAPTER 2: REVIEW OF THE LITERATURE

This chapter provides the context for a study of medical students' implicit theories of intelligence (ITI), and grittiness, in order to better understand the self-regulatory processes of goal setting, goal operating, and goal monitoring that occur when a student is first learning gross anatomy. This study attempted to understand the relationships between medical students' beliefs about intelligence and grittiness in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy. In order to provide context for this research question, relevant work in this chapter is divided into four sections. First, the review provides a historical overview of gross anatomy in the context of medical education, and its evolution in recent decades. It also provides background, context, and an examination of the current concerns regarding medical students and the evolving nature of anatomical education. Secondly, implicit theories of intelligence are discussed, and a specific overview is given of how implicit theories of intelligence have been explored in medical education. Third, the non-academic trait termed grit is examined; focusing on the defining characteristics of a gritty individual, and concluding with a discussion of the limited research that has been conducted on grit in the field of medical education. Finally, the self-regulatory processes of goal setting, goal operating, and goal monitoring are reviewed; in addition, the ways in which implicit theories of intelligence and grit can predict certain aspects of goal setting, goal operation, and goal monitoring are examined. The chapter concludes by highlighting the potential impact that understanding the relationship between medical students' ITI and grittiness can have on illuminating the self-regulatory processes at play in learning gross anatomy.

Historical Overview: Gross Anatomy in Medical Education

It has long been tradition that anatomy has served as one of the cornerstones of medical education. From the novice medical student to the experienced physician, for over one hundred years the old Halsteadian apprenticeship model of see one, do one, teach one has played a central role in the successful education of physicians (Pillai & Dennick, 2012). This method has been and still is used in many of the basic medical sciences, including anatomy. Anatomy is a learned art—a learned art of observation, dissection, movement, and application, all on a canvas of skin, connective tissue, muscle, bone, and nerve.

Yet, prior to the 20th century, medical education was at best inadequately regulated, inconsistent, erratic, and of variable/questionable quality (Gorman et al., 2000). However, with the release of the 1910 Flexner Report, an in-depth study on medical education across the United States and Canada, considerable changes were set in motion (Flexner, 1910). Many of the unregulated, for-profit medical schools disappeared and were replaced by accredited medical schools with standardized programs of structured medical instruction (Louw et al., 2009). Anatomy became a standard part of the basic science curriculum and for many years "occupied a significant portion of the first year (of medical school) that included formal lectures and laboratory dissection of the entire body" (Louw et al., 2009, p. 374). Moreover, traditional anatomy consisted of "long periods of studies with extensive examination…and continues to [have] a central position in providing a skeleton for further learning about the human organism and its diseases" (Wilhemsson et al., 2010, p. 154).

It is currently recognized that gross anatomy, in conjunction with the gross anatomy laboratory, are central in teaching our future physicians the necessary human morphology, relevant terminology, spatial relationships, clinical correlations, and structural three-dimensionality required for safe and competent practice (Yammine, 2014). The anatomical literature and medical educational system agree on the centrality of anatomy to successful medical practice, this even includes international medical councils, with the UK's General Medical Council (GMC) reporting that "to some extent, the quality of medical education that students receive would determine the quality of care the public receives" (Yammine, 2014, p. 184). However, over the past three decades medical education, especially anatomy, has undergone massive changes (Patel & Moxham, 2006; Yammine, 2014). These changes can be better understood when categorized in the following four areas: (1) intellectual changes, (2) infrastructural changes, (3) methodological changes, and (4) scope-of-focus changes. These changes and emerging developments have contributed to the evolving role and identity of anatomical education, a role that some have characterized as the "devolution of anatomic curricula" (Dyer & Thorndike, 2000; Yammine, 2014, p. 185). Details concerning all four categorical areas of change are subsequently discussed.

Intellectual Changes in Anatomical Instruction/Medical Education

The required knowledge and clinical skill base for medical practice continues to expand to unprecedented, overloaded levels in all fields of medicine (General Medical Council (UK), 2003; Sullivan et al., 2004; Horowitz et al., 2014). With patient care delivery becoming vastly more complicated amid the overwhelming intellectual demands, the aim of undergraduate medical education continues to be the preparation of medical students for supervised graduate medical education, i.e., residency training, which will progress to competent, unsupervised professional practice. However, many researchers have "identified a decline in emphasis given to gross anatomy teaching and training" and concerns over the adverse effect of declining anatomical knowledge in medical graduates have been expressed by practicing clinicians, residents, and advanced standing medical students both in the United States and abroad (Moosman, 1980; Fasel, 1993; Pabst, 1993; Cottam, 1999, p. 55; Waterston & Stewart, 2005; Bergman et al., 2008; Fitzgerald et al., 2008; Mitchell & Batty, 2009; Bhangu et al., 2010). It is argued that the consequences of this deficiency in optimal anatomical knowledge will have "implications on patient safety," and that with the "rise of minimal[ly] invasive approaches in modern surgery [it] could have an impact on the actual surgical anatomy knowledge" (Yammine, 2014, p. 185).

With the many constraints on time, resources, and the massive volume of material to learn, it is not surprising that research has shown that some medical students have adopted a surface approach to learning (Lindblom-Ylanne &Lonka, 1996). When asked, advanced medical students expressed concern that while they understood anatomy in a static sense, they lacked knowledge of the details and the dynamic aspects of integrating and applying anatomical structures to clinical problem solving (Wilhelmsson et al., 2011). In addition to medical students, research has shown that many residents have questioned and/or expressed unease over the completeness of their gross anatomy education, and that even though residents spend "20% of their time teaching and contribute to approximately one-third of a medical student's knowledge," they often "assume teaching responsibilities without adequate preparation" (Andrew, Starkman, Pawlina, & Lachman, 2013, p. 385). All this while the majority of residency programs report that "gross anatomy is either extremely important or very important to mastery of their discipline, and rank it as the most important basic science" (Cottam, 1999, p. 55). When asked, residents expressed an "interest in lectures and seminars, or specialized courses in anatomy at the beginning of their postgraduate training," indicating a desire for further anatomical knowledge, training, and a content refresher (Pabst & Rothkotter, 1997, p. 432).

Specific concern has also been raised by clinicians, that the "current anatomical education of medical students is inadequate, and perhaps below the minimum necessary for safe medical practice" (Waterston & Stewart, 2005, p. 380). Now, while this study had a lower than desired response rate (45%), the insight offered is still compelling. The study goes on to highlight the fact that physicians have consistently encountered medical students who have been particularly weak or deficient in their central and peripheral nervous system anatomy as well as their musculoskeletal anatomy; surgeons recounted medical students who had never heard of the vagus nerve (a nerve necessary for survival) or who were unable to name major long bones in the body (like the humerus) (Waterston & Stewart, 2005). Surgeons are not alone, residency program directors have also expressed the need for residents "to arrive more proficient in clinical application, general knowledge, and cross-sectional application" of anatomy (Cottam, 1999, p. 55).

Finally, numerous educational bodies, foundations, and professional task forces, including the Association of American Medical Colleges (AAMC), The Commonwealth Fund, the Institute of Medicine, and the Carnegie Foundation for the Advancement of Teaching, have criticized the preparation for professional medical practice. These groups criticize "medical education for emphasizing scientific knowledge over biologic understanding, clinical reasoning (and) practical skill" (Cox & Irby, 2006, p. 1339). As the AAMC has pointed out, "the knowledge, skills, and attitudes that doctors will need to provide high quality medical care in the 21st Century are different from those that have been needed in the past," and the Association has become "increasingly aware of apparent deficiencies in the design, content, and conduct of the clinical education of medical students" (Nutter & Whitcomb, 2001, p. 1). The Carnegie Foundation found that "medical training is inflexible, excessively long and not learner centered," observing "poor connections between formal knowledge and experiential learning…[and] that medical education does not adequately make use of the learning sciences" (Cooke, Irby, & O'Brian, 2010).

So, whether it is the voices of medical students, residents, practicing physicians, educational bodies, or professional task forces, the concern over the changing intellectual demands in medicine and deficiencies specific to anatomy require that we come to a better general understanding of how students are learning anatomy. One way to do this, which has not yet been explored, is to examine the implicit theories of intelligence and grit of medical students, to determine how these fundamental characteristics and beliefs, centered at the core of learning, are driving learning in this foundational science.

Infrastructural Changes

The dramatic growth in size and complexity of medical schools over the last century has necessitated infrastructural changes, including curricular changes that embrace the integration of disciplines, a decrease in allotted student contact time, a condensed anatomy curriculum in general, and an increasing use of systems-based and clinical programs to teach this foundational science (Barchi & Lowery, 2000; Louw et al., 2009; Pandey & Zimitat, 2007). In addition, infrastructural changes can be attributed to medical schools facing budget cuts, trying to balance a decrease in curriculum hours, having to function with a reduced supply of qualified gross anatomy instructors, changes in the methodologies used in the classroom, and a reduction in the amount of time dedicated to anatomy as a subject (Cottam, 1999; Waterston & Stewart, 2005, Yammine, 2014). All have contributed to the concern that these changes may be having "an adverse effect on the level of anatomical knowledge of medical graduates" (Pandey & Zimitat, 2007, p. 7).

Methodological Changes

The debate on how to best learn, and thus teach anatomy, is as varied as it is complex. However, regardless of the educational environment or tools used to learn anatomical content, the intent has long been to "teach anatomy in a purposeful way" that guarantees lasting understanding and application in practice (Wilhemsson et al. 2010, p.155). So, setting aside some of the stated challenges that students and medical schools are currently facing, it would be hard to argue that anatomical learning is not occurring in medical school (Drake, McBride, Lachman, & Pawlina, 2009). Learning of anatomy does occur, albeit to a varying degree and through a wide array of methodologies (Smith, 2005; Waterston & Stewart, 2005; Tibrewal, 2006; Fitzgerald et al., 2008; Bhangu et al., 2010). Unfortunately, some of these methodologies have been described as being better than others, and there is an "increasing amount of evidence demonstrating that anatomy teaching is considered substandard by students, teachers, junior doctors, and experienced clinicians" (Yammine, 2014, p. 185).

So, what are the methods that medical students typically use to learn anatomy within this atmosphere of curricular change, diverse pedagogy, and ostensibly limited resources? Research has shown that it is not uncommon for medical students to use one of the following five approaches to learn anatomy:

> To (i) avoid the task; (ii) memorize facts; (iii) memorize chunks of information; (iv) understand selected aspects of the anatomical site/structure/concept; and (v) try to comprehend the whole anatomical site/structure/concept and its constituent elements." (Pandey & Zimitat, 2007)

While the scope of this particular study is not to review the aforementioned approaches to learning, it will briefly examine three areas of methodological changes that are impacting how anatomy is being taught, and subsequently learned. Three trends that are relatively new in the field of anatomy, and in the opinion of practicing clinicians and surgeons are having a significant impact on the education of our future physicians.

The first methodological change discussed here is the incorporation of 3-D, or virtual technology into the education of physicians. As some practitioners and educators in the field have pointed out, "The future of medical education is no longer blood and guts, it's bits and bytes," doctors are more than ever "trading cuts for clicks" when learning anatomy (Gorman et al., 2000, p. 353). Research points to the fact that many clinicians, surgeons, and educators are of the opinion that there is a need to teach medical school students anatomy in a three-dimensional manner. However, while the importance of learning anatomy in a three-dimensional approach is rarely contested, the way in which the three-dimensionality of the subject is taught is another debate. As Marks (2000) stated, "Three-dimensional technology in health care has much to contribute.

Teaching these procedures to graduate and postgraduate physicians is another matter" (p. 449).

Some have argued that a switch to using a 3-D virtual reality program or computer simulated body can effectively replace the traditional act of dissecting a human body. Yet, the 'virtual reality' displayed on a screen has to be:

> Interpreted by and related to 3-D images in the brain of the user, (and) the training of postgraduate physicians in clinical 3-D technologies is compromised by the inadequate 3-D backgrounds they bring to these programs from their undergraduate training in anatomy. (Marks, 2000, p. 449)

As such, many anatomists believe that classic human cadaveric dissection gives the student the clearest view of 3-D structures along with a global spatial understanding of organs and organ systems (McLachlan et al., 2004). The AAME (Academic Alliances in Medical Education) has even gone to the extreme to say that, "electronic representations of the body as alternatives to cadaver dissection, whilst valuable DO NOT provide sufficient learning experience to understand the complex human body structure," (Abu-Hijleh, 2010). With further research indicating, "there should be room for the historically proven traditional methods such as dissection," and that many "accomplishments of great surgeons who have been trained by [dissection] abound in the history of medicine" (Yammine, 2014, p. 186).

However, one cannot completely ignore the arguments of those who are in support of using a 3-D, virtual reality (VR), or an augmented reality (AR) platform for portions of medical education. Indeed, there is research which shows that the use of a virtual reality model would address some of the costs and ethical concerns over the use of cadavers, and reduce the associated stress that some medical students have when using human cadavers (Finkelstein & Matters, 1990; Charlton, Dovey, Jones, & Blunt, 1994).

An augmented reality platform also has the potential to "offer a safe, suitable and cost-effective training setting in which whole, real-world training tasks can be practiced. In such environments, learners can make errors without adverse consequences, while instructors can focus on learners rather than patients" (Kamphuis, Barsom, Schijven, & Christoph, 2014, p. 3). Technology has even advanced to the point where a "3-dimensional printer makes it possible to convert patients imaging data into accurate models, thus allowing the possibility to reproduce models with pathology," allowing large numbers of students to learn basic surgical procedures in a "safe environment until they can master it" (Waran et al., 2013, p. 1). By utilizing emerging technologies, be it computer simulations, 3-D models, or realistic replicas that include pathological conditions reflecting real patient data, research indicates that it "should shorten the learning curve" (Waran et al., 2013, p. 3). But the question remains, where is the appropriate balance between the actual and the virtual? Studies are emerging on the effectiveness of 3-D digital animations in teaching human anatomy at the medical student level, and conclude that those students learning in 2-D are still outperforming those learning in 3-D, except for in areas of the body that require high levels of spatial ability, like the upper limb (Hoyek, Collet, Di Rienzo, De Almeida, & Guillot, 2014). Our understanding of the extent to which these methodological changes are influencing the foundation of anatomical understanding, particularly with the novice medical student, is limited at best.

The second methodological change discussed here is the divergent trend away from the traditional lecture model to a more student driven model, such as problem-based learning (PBL). Problem-based learning is a small group-based curricular model in which students are given a clinical case as a starting point that is related to course content, where "learning takes place in a meaningful and authentic context…to connect clinical phenomena to underlying basic science concepts" (Prince et al., 2003, p. 15). However, a series of recent studies have suggested there may be reason to have concern over a PBL approach. Data shows that although there are no actual differences in levels of knowledge between a PBL and non-PBL school, students have reported feeling a deficiency in basic science knowledge, particularly in anatomy, when entering residencies and clerkships when coming from a PBL based curriculum (Prince et al., 2003; Prince et al., 2000). Again, the question remains, regardless of the type of content delivery—be it lecture-based or PBL—do we truly understand how methodologies are influencing how students set and achieve their learning goals in anatomy?

Finally, the third methodological change discussed here is the rise of integrated curricula. In brief, the purpose of an integrated curriculum is to effectively prepare clinicians to practice intellectually sound medicine based on the blending of anatomy with other core sciences. Selected research has shown that these types of courses can be successful when they use common clinical cases to guide the selection of content, particularly with respect to the condensed anatomical material found embedded within (Rizzolo et al., 2006; Inuwa, Taranikanti, Al-Rawahy, Roychoudhry, & Habbal, 2012). More specifically, these clinical courses do have value when they seek to integrate dissection, computer exercises, radiology, and small group discussion in the classroom, all while using problem-solving exercises centered on formative assessment (Rizzolo et al., 2006). If done well, a clinical approach can help to "focus students' attention on the critical skill of spatial reasoning and the application of structure-function relationships, while freeing students from endless hours of memorization that produces little true learning" (Rizzolo et al., 2006, p. 151). However, in some cases integrating the curricula too much has given "rise to concern about the level of knowledge attained by students graduating from innovative programmes…for anatomy in particular" (Yammine, 2014, p. 185). Regardless of the integrated nature, or clinical applicability of an anatomy course, it appears that our understanding of the impact of these methodological changes on students' acquisition of anatomical knowledge is still fragmented. Perhaps it will be within the context of examining the ITI and grit of our medical students that we can come to a better understanding of the unseen forces driving anatomical learning in this methodologically diverse, and evolving environment.

Changing Scope-of-Focus

An increased push to emphasize teaching clinically relevant or procedural based anatomy, over the traditional fact-dense classic anatomy, is a push lauded by many as a necessary progression in the field (Yammine, 2014). A progression that ensures the relevance of anatomy in contemporary medical contexts, future patient care, and in the application of the science to clinical care (Older, 2004; Ahmed et al., 2009; Regan de Bere & Mattick, 2010). Simultaneously, while this focus on clinical content has led to a positive increase in the use of relevant surface, radiological, and clinical approaches to identify anatomical structures and pathologies in the body, many argue an even greater focus must be placed on a clinically oriented syllabus and the teaching of surface anatomy (Yammine, 2014). This is as debates over what comprises essential knowledge in anatomical education are still ongoing; as are debates over the relative merits of using non-traditional approaches in undergraduate medical education (McLachlan & Regan de Bere, 2004; Patten 2007; Regan de Bere & Mattick, 2010).

Now, while anatomy is typically only part of the first two years of a students' undergraduate medical education, as a foundational basic science, the impact of the evolving intellectual, infrastructural, methodological, and focal components of the field are not well understood. This becomes especially apparent when we consider the practical outcomes of medical students' preparation, with many feeling that today's incoming residents are not as prepared as they should be, or could be, with respect to their anatomical knowledge, competence, and ability to apply their knowledge (Balla, 1990; Cottam, 1999; Fitzgerald et al., 2008; Lazarus et al., 2012).

Understandably, these four areas of change in the field (intellectual, infrastructural, methodological and scope-of focus) then make it especially difficult for medical students to identify the most effective way in which to learn anatomy in order to ensure competence; perhaps even impacting medical students' ability to set effective learning goals in the first place. It is amid the changing identity of anatomy in the evolving medical school environment that our understanding of the perspectives of the medical students, who are at the forefront, experiencing and working within these changes firsthand, has not kept up. Thus, in the following sections implicit theories of intelligence (ITI) and grit are discussed in the context of medical education and anatomy, specifically discussing how they can further our understanding of the factors driving anatomical learning.

Implicit Theories of Intelligence

One framework that provides a way in which to view intelligence can explain variations in learning behavior, and can better our understanding of why such stark inconsistencies exist in the anatomical knowledge that medical students enter residency with, is self-theories of intelligence. This theory is commonly referred to as one's implicit theory of intelligence (ITI), due to the fact that the way an individual views or defines their own intelligence is often not explicitly articulated to themselves or to others, and thus remains implicit (Teunissen & Bok, 2013). In actuality, there are two major implicit theories of intelligence (ITI) used in social cognitive research that provide a way in which to think about how people view intelligence. The first is an entity theory of intelligence, and the second, is an incremental theory of intelligence. In a general sense, ITI are the beliefs one holds about the fixedness or malleability of intelligence. One belief is that intelligence is a fixed trait (reflecting an *entity* theory), and the second belief is that intelligence is a malleable quality (reflecting an *incremental* theory) (Dweck, 2000). Entity theorists hold that intelligence is a concrete entity, that "one either has the ability to perform successfully in a certain task or one doesn't"; in contrast, incremental theorists believe intelligence to be malleable, and something that can "be developed or cultivated through effort" (Tuenissen & Bok, 2013, p. 1065).

Understanding the implicit theories of intelligence of an individual is important, due to the fact that relatively often, these beliefs determine an individual's attitude and behavior, and have the ability to predict achievement across a particular transition (Blackwell, Trzesniewski, & Dweck, 2007; Garcia-Cepero & McCoach, 2009). For example, Dweck and Molden (2005) cited that there are profound educational consequences for individuals depending on the type of theory they believe in, and that depending on whether one views intelligence as fixed or malleable will predict the type of learning goals an individual sets. For example, students who hold an entity theory of intelligence are likely to endorse and set performance goals.

> Believing that their intelligence [is] fixed, they are more concerned with documenting their intelligence through their performance. In other words, if they [have] a fixed amount of intelligence, they believe they had better demonstrate they have a lot of it. (Dweck & Grant, 2008, p. 407)

In essence, performance goals are all about measuring one's ability to perform a task. Conversely, students who hold an incremental theory of intelligence are likely to endorse and set learning, or mastery goals, "believing that their intelligence could be cultivated, they [are] more concerned with gaining skills and knowledge" (Dweck & Grant, 2008, p. 407). These mastery goals are all about mastering new things, increasing intelligence; and failure along the way has "nothing to do with the student's intellect. It simply means that the right strategies have not yet been found. [So] Keep looking" (Dweck, 2000, p. 16).

How individuals fit into each respective category is interesting. Approximately 20% of the population fits into a hybrid group consisting of those who hold both entity and incremental beliefs, while the remainder of individuals are equally spread between the two beliefs—half are primarily entity theorists, and half are primarily incremental theorists (Dweck & Grant, 2008). Interestingly, ITI can also be subject, or domain-specific, even for the same individual; that is one individual may hold more than one theory of intelligence depending on the subject matter or attribute in question. For example, an individual can "believe that their intelligence is fixed but their personality is malleable," or that "their math ability is fixed but their verbal abilities can be developed" (Dweck & Molden, 2005, p. 123).

These implicitly held theories of intelligence "can give us entrée into the meaning systems people use to construct meaning in competence-relevant situations," and in turn manifest themselves into self-regulated behaviors that impact learning (Pintrich & Schunk, 2002; Dweck & Molden, 2005, p. 122). Illuminating the meaning systems of medical students can help us understand, "how they attract or highlight certain competence goals and certain attributions, which go on to foster particular strategies," strategies that can include goal setting, goal operating, and goal monitoring—all of which are strategies that are discussed in more detail at the end of this chapter (Dweck & Molden, 2005, p. 122). Nevertheless, in the context of medical education, specifically anatomy, these two theories can be thought of as separate ends of a continuum. That is, medical students often differ in a key way, namely in the extent to which they believe that their intelligence is fixed versus believing their intelligence is malleable. So, "although two people may be similar in intellectual aptitude, their beliefs about the malleability of intelligence may differ, resulting in differences in their academic performance and subsequent motivation" (Shively & Ryan, 2013, p. 242).

The method used to determine an individual's implicit theory of intelligence is Dweck's Implicit Theories of Intelligence Scale (ITIS) survey. Initially developed in 1989 by Dweck and Henderson, the ITIS only consisted of entity items that were used to assess an individual's beliefs about intelligence (e.g., "Your intelligence is something about you that you can't change very much"—a statement reflecting an entity view of intelligence) (Dweck, 2000). However, more recently incremental items were added to the scale (e.g., "You can change even your basic intelligence level considerably"—a statement reflecting an incremental view of intelligence), which helped lead to the development of the current eight-item survey; a survey that includes both entity and incremental theory statements (Dweck, 2000; Deemer, 2004). The survey scale has respondents indicate their level of agreement with the eight statements using a six-point Likert scale; validation studies support the use of this scale, with Cronbach's Alphas ranging from 0.94 to 0.98, indicating a high internal consistency (Dweck, 2000). Dweck also found the test-retest reliability of the measure over a two week period to be 0.80, suggesting that the scale has stability in its assessment of theories about intelligence (Deemer, 2004).

Dweck (2000) said, with respect to the two theories (entity and incremental) they "seem to create entirely different frameworks for students…once students adopt a theory of intelligence, it affects what they value, how they approach intellectual tasks, and how they respond to what happens to them" (p. 16). Specifically, in educational settings, it also appears that the "adoption by the students of a fixed-entity or a malleable-incremental theory of intelligence is associated with different patterns of behavior" (Gonida, Kiosseoglou, & Leondari, 2006, p.224). This results in incremental theorists who are more likely to display adaptive patterns of behavior, adapting to situations in order to learn from them regardless of the final outcome; and entity theorists who are more likely to display maladaptive patterns of behavior, that may include behavioral or cognitive components that reflect a desire to perform well at all costs, even if it is at the expense of deep learning (Gonida et al., 2006).

However, we unfortunately know very little about the ITI at play in the medical school setting, or the ITI of individual medical students. Research has yet to examine the ITI of medical students, or the ways in which their views on intelligence impact grit, or the self-regulatory processes of goal setting, goal operating, and goal monitoring involved in learning gross anatomy. Indeed, there is very limited research that examines implicit theories of intelligence in medical education in general, none of which is specific to anatomy. The literature concerning ITI in medical education revolves around a general discussion of using the theory as a framework in medical educational research, offering perspective on why a more thorough understanding of ITI is advantageous (Teunissen & Bok, 2013). This research also recognizes the implications for our future physicians. According to Teunissen & Bok (2013),

> In medicine, holding either a performance or learning goal orientation exclusively can be problematic given the tasks in this field of endeavor are dynamic and complex, professionals are required to perform well for the good of their patient and at the same time to learn new skills on a continuous basis, and [student] doctors must be able to transfer skills to new tasks. (p. 1066)

It is this careful balancing act we require of our future doctors. And as previously mentioned, the ITI an individual holds while establishing the foundation of the medicine they will eventually practice, influences their self-regulatory processes of goal setting, goal operating, and goal monitoring while learning anatomy. While these self-regulatory processes are discussed in more detail in a subsequent section of this chapter, it is important to note that medical education could benefit greatly from using and understanding the ITI of students in order to better support our future physicians in the balancing act that is medicine (Teunissen & Bok, 2013).

Grit

A myriad of studies have examined the changing identity of anatomy in the evolving medical school environment (Pabst & Rothkotter, 1997; Cottam, 1999; Waterston & Stewart, 2005; Pandey & Zimitat, 2007). Changes that some believe are having "an adverse effect on the level of anatomical knowledge" of medical graduates (Collins, Gien, Hulsebosch & Miller, 1994; Waterston & Stewart, 2005; Pandey & Zimitat, 2007, p. 7; Fitzgerald et al., 2008); where "the long-term consequences of this shortage in optimal anatomical knowledge is thought to have implications on patient safety" (Yammine, 2014, p. 185). Yet, our understanding of the academic, and perhaps more importantly, non-academic factors that drive successful anatomical knowledge acquisition and development are limited. This is even as research has indicated that educators feel that "clinical year medical students' ability to apply anatomical knowledge [is] equally low across all aspects of clinical care" (Lazarus et al., 2012, p. 194).

As it currently stands, much of the research in the field of anatomical education has been focused on designing, implementing, and assessing practical instructional tools, pedagogies, and assessment methods; while studies in the broader field of medical education are found to be somewhat more varied in their assessment of factors associated with learning success. This includes research that qualitatively explores the factors associated with academic achievement in medical school; reporting that internal motivation is an important factor playing a role in the success of high achieving students (Abdulghani et al., 2014). However, even in the broader field of medical education, most studies have not gone beyond examining single aspects of predictive academic success, aspects such as previous academic performance, or the effect that stress has on achievement (Ferguson, James, & Madeley, 2002). In addition, research has given little attention to the important non-academic factors (beyond examining the variables of gender and ethnicity) that drive success in medical school, such as learning styles or personality (Lumb & Vail, 2004; Kumar, Sharma, Gupta, Vaish, & Misra, 2014). This becomes even more significant, as many studies have begun to point to the same conclusion in the field of medicine, that is, non-academic factors may be more important than they have previously been credited for being (Naylor, Reisch, & Valentine, 2008; Burkhart, Tholey, Guinto, Yeo, & Chojnacki, 2014).

One such important non-academic factor that drives learning is grit. Grit was first modeled by Duckworth and colleagues in 2007, and is defined as the "perseverance and passion for long-term goals," and can quantitatively measure the ability of an individual to maintain a sustained and focused effort throughout an extended period of time "despite failure, adversity, and plateaus in progress" (Duckworth et al., 2007, p. 1088). Duckworth et al. (2007) points out that more than 100 years before their work on grit, research by Galton concluded similar findings, that ability alone did not bring success in any field, and that high achievers "are triply blessed by ability combined with zeal and with capacity for hard labour" (Galton, 1892, p. 33).

However, the current modeling of grit goes beyond previous work, finding that grit is a superior predictor of success in a number of high achievement and high stress fields, such as the military, academia, law, and medicine (Duckworth et al., 2007). In fact, grittier individuals are less likely to drop out of their respective life commitments, more likely to complete the tasks they begin, and grit can predict retention "over and beyond the established context-specific predictors of retention (e.g. intelligence, physical aptitude, Big Five personality traits, job tenure)" (Eskreis-Winkler et al., 2014, p. 2). Certain universities and graduate admissions programs have even begun to seek out students who exemplify quantifiable grit; as is the case with students applying to Fisk-Vanderbilt University, where the interview protocol has been adapted to rank certain interviewee responses on a grit scale for selection (Powell, 2013).

Grit has been shown to be associated with lifetime educational attainment, academic performance at elite universities, and success in National Spelling Bees (Duckworth et al., 2007; Duckworth, Kirby, Tsukayama, Berstein, & Ericsson, 2011). It is a predictor of teacher effectiveness (Duckworth, Quinn, & Seligman, 2009; Robertson-Kraft & Duckworth, 2012), and in multiple studies has "accounted for significant incremental variance in success outcomes over and beyond that explained by IQ, to which it was not positively related" (Duckworth et al., 2007, p. 1098).

It is important to note that even though grit has accounted for successes beyond that explained by IQ, grit overlaps with certain aspects of conscientiousness, a concept that includes being careful, reliable, thorough, organized, and self-controlled; but grit is different in that "its emphasis [is] on long-term stamina rather than short-term intensity" (Duckworth et al., 2007, p. 1089). Grit also differs from a need for achievement. The need for achievement can be described as "a drive to complete manageable goals that allow for immediate feedback on performance," which is different than grit, because in contrast, grittier individuals "deliberately set for themselves extremely long-term objectives and do not swerve from them—even in the absence of positive feedback" (McClelland, 1961; Duckworth et al., 2007, p. 1089). In addition, research suggests that prodigious talent is not a guarantee of grittiness, in fact, "in most samples, grit and talent are either orthogonal or slightly negatively correlated," which makes it even more phenomenal that "the most accomplished scientists, novelists, artists and entrepreneurs are dramatically more successful than would be expected were achievement distributed in a normal bell curve" (Duckworth & Eskreis-Winkler, 2013).

The field of medical education, and in turn, the field of anatomy, could make much more use of this concept of grit. As it stands, the only real examination of grit in the medical field has been in three areas: first, examining the association between grit and rural versus nonrural physician satisfaction and retention (Reed, Schmitz, Baker, Nukui, & Epperly, 2012); second, in the field of surgery, to evaluate a potential root cause for resident attrition by characterizing the relationship between the grit of residents and program dropout (Burkhart et al., 2014); and finally examining the relationship between grit and resident well-being in general surgery, and how this affects success within training programs (Salles, Cohen, & Mueller, 2014).

In terms of the first area, namely rural versus nonrural physician satisfaction, research found that regardless of location, specialty care physicians reported significantly higher levels of grit, which included higher levels of ambition and satisfaction in their practice (Reed et al., 2012). In the second area of research, which concentrated on surgical resident attrition, initial findings lacked statistical significance to conclude grit's effect on dropout, but did find that those residents who left participating programs in the 2012-2013 academic year had below median levels of grit. Furthermore, this study did highlight the importance of a question posed in another study, by Duckworth & Eskreis-Winkler (2013). The question revolved around identifying the mechanisms that link grit to achievement. And while the study concerning surgical resident attrition could not answer that question, Duckworth and Eskreis-Winkler began to, stating that "one important mechanism is deliberate practice, defined as practice activities designed to improve specific aspects of performance" (Duckworth & Eskreis-Winkler, 2013). Particularly finding that it was the "hardest, least pleasurable [parts of] practice that really paid off" for individuals; simply put, the grittiest individuals were able to do more (Duckworth & Eskreis-Winkler, 2013). Finally, with respect to the third area of research, which examined the relationship between grit and resident well-being in general surgery residents, it was found that grit was predictive of later psychological well-being, and that grit can be used to identify those residents who are at greatest risk for poor psychological well-being in the future. Researchers even went so far as to suggest that grit levels could be used to identify residents who could benefit from counseling or additional support in the present, in order to improve their coping skills in the future (Salles et al., 2014).

However, even once one considers the three aforementioned studies focused on grit in the field of medicine, a large gap in the literature remains; we know very little about grit in our medical students, and virtually nothing about how grit affects how one attempts to learn anatomy. We are left to ask, how gritty are our medical students? Is practice, and practice of the hardest parts of anatomy enough? Should our focus be placed on encouraging medical student grittiness, rather than on testing the latest technology, or trying out the newest curricular pedagogy? What mechanisms link grit to implicit theories of intelligence, and to the self-regulatory processes (which are subsequently discussed) of goal setting, goal operating, and goal monitoring? Do medical students with high levels of grit display more effective goal achieving strategies in order to learn anatomy? Do grittier individuals self-regulate in ways that are distinct?

The answers are, we simply do not know. There is a great need to explore the relationships between ITI, grit, and the self-regulatory processes in play when learning anatomy, especially in light of our changing anatomical education landscape.

Putting it Together: Implicit Theories of Intelligence, Grit, and Self-Regulatory Processes

For the purposes of this study, self-regulation is defined as "the sense of purposive processes, the sense that self-corrective adjustments are taking place as needed to stay on track for the purpose being served, and the sense that the corrective adjustments originate within the person" (Carver & Scheier, 2010, p. 3). Furthermore, three core processes underlie self-regulation in learning as established by Carver and Scheier's (1998) self-control theory, these are: goal setting, goal operating, and goal monitoring. The focus of this study is to better understand the relationships between medical students' beliefs about intelligence and grittiness in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy. As such, the following sections explain the core processes of self-regulation, and the ways in which ITI and grit play a role in each domain.

Goal Setting (performance goals vs. learning goals)

Bandura and Locke argue, "Humans are motivated by foresight relative to where they want to be"; this is an important insight when considering how individuals set personal goals (Oettingen & Hagenah, 2005, p. 652). The personal goals that entity and incremental theorists set, often differ and research suggests that these goals form the link between ITI beliefs and subsequent behavior. For example, holding an entity theory often leads an individual to have *performance goals*—goals that are inextricably linked to performing well at a particular task, and are accompanied by a fear of failure and desire to make a good impression (Teunissen & Bok, 2013). Since intelligence is fixed to these individuals, demonstrating its presence through successful task completion becomes crucial and is accomplished by placing great importance on tangible goal achievement. Conversely, those individuals holding an incremental theory often have *learning goals*—goals that avoid placing such importance on performance, and focus more on gaining new knowledge and improving skills with learning. Since intelligence is malleable to the incremental theorist, failure is embraced as a way in which to figure out what works and what does not, and individuals are willing to persist even in the face of poor performance (Teunissen & Bok, 2013).

As previously mentioned, grit also has an influence on the goals one sets; with grittier individuals typically setting goals that can be defined as learning goals. For "individuals high in grit deliberately set for themselves extremely long-term objectives and do not swerve from them—even in the absence of positive feedback"; these are individuals who avoid setting goals that are too easy or too hard, as they do not need constant achievement validation (Duckworth et al., 2007, p. 1089).

Goal Operating (helpless vs. mastery-oriented reactions)

When it comes to goal operating, or in other words, how individuals react to the processes involved in achieving one's goals, research has repeatedly pointed out that "the pivotal issue in achieving competence is how people respond to negative feedback" (Oettingen & Hagenah, 2005, p. 657). What ITI and grit both bring into the conversation, is that these traits directly and indirectly (i.e. by encouraging certain goals) "set up students' reactions to difficulty, which [go] on to predict the course of their self-esteem and achievement"; more specifically "ITI and goals together set up a framework in which people interpret and respond to setbacks" (Dweck & Grant, 2008, p. 408). In the entity system, with a performance goal framework, setbacks can result in helpless-oriented reactions; reactions that may include an ineffective strategy of coping in the face of setbacks, or even a decreased ability to acknowledge failure in the first place (Robins & Pals, 2002; Cury, Elliot, Da Fonseca, & Moller, 2006; Blackwell et al., 2007). Entity theorists, who may show a helpless oriented response to difficulty see "competence [as] something people have and display right away," and failure almost immediately calls into question one's core intelligence and inherent ability as an individual (Dweck & Molden, 2005, p. 128).

Conversely, individuals with an incremental theory of intelligence and high levels of grit often embrace a learning goal framework, meeting setbacks with a mastery-oriented reaction; mastery-oriented in the sense that setbacks result in a response or reaction that is only "more vigorous and effective" to accomplish the goal at hand (Dweck & Grant, 2008, p. 408). Setbacks are seen as events that provide more information, because "competence is something that grows over time through effort," and failure is seen as part of the process of learning, not an indication of deficient intelligence or failure of self (Dweck & Molden, 2005, p. 128).

In the context of ITI, the helpless versus mastery-oriented reactions create a meaning system for individuals "in which ability and effort are unequally weighted in the two alternative frameworks; ability is more heavily weighted by entity theorists, whereas effort is considered more important by incremental theorists" (Gonida et al., 2006, p. 224). Furthermore, grittier individuals often embrace the "importance of working longer without switching objectives," illustrating yet again, a mastery-oriented response (Duckworth et al., 2007, p. 1098). Finally, experimental evidence has shown that those with an incremental implicit theory of intelligence, and perhaps more grit, "construe failures and setbacks as opportunities to learn and improve, rather than as evidence that they are permanently lacking in ability" (Duckworth & Eskreis-Winkler, 2013).

Goal Monitoring (negative emotions vs. optimistic expectations)

When it comes to monitoring ones goals, entity and incremental theorists tend to attribute their performance or progress towards a goal to different factors, yet both types of theorists view ability and effort as important determinants. However, how they weigh these elements does differ (Dweck, 2000). Entity theorists tend to attribute performance or progress to personal *ability*, whereas incremental theorists and grittier individuals are more likely to attribute their performance to personal *effort* (Dweck & Leggett, 1988; Hong, Chiu, Dweck, Lin, & Wan, 1995; Duckworth et al., 2007). Essentially, entity theorists believe that for the most part, intelligence is fixed, and even though new things can be learned, they either have the raw ability or they do not; and that when it comes to evaluating their potential for goal success, they report more negative emotions, feelings of vulnerability, and anxiousness when it comes to monitoring their performance—good or bad (Duckworth et al., 2007). While on the other hand, incremental theorists and grittier individuals believe that hard work will lead to an evolving, increased intelligence; often reporting greater confidence and optimistic expectations when it comes to monitoring their potential for goal success (Dweck, 2000).

Conclusion

The self-regulatory processes of goal setting, goal operating, and goal monitoring are actions that medical students find themselves constantly doing. These actions are generally done with purpose, are proactively self-corrected when need be, and maintained in order to reach a desired goal—in this case learning gross anatomy. While some studies have shown null effects (Biddle et al., 2003; Ommundsen et al., 2005; Doron et al., 2009), many others have demonstrated that implicit theories of intelligence predict self-regulatory processes; and the self-regulatory processes of goal setting, goal operating, and goal monitoring are influenced by an individual's grittiness. Particularly in that grittier individuals have a tendency to maintain focused interest, show sustained effort and are less likely to quit the task at hand (Thompson & Musket, 2005; Kray & Haselhuhn, 2007; Nussbaum & Dweck, 2008; Eskreis-Winkler et al., 2014).

However, in the context of medical students learning anatomy, we do not fully understand ITI, grit, or the key moderators between students' ITI, grit, and the self-regulatory processes that directly impact learning. Thus the aim of this study was to explore the relationships between medical students' beliefs about intelligence and grittiness, in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy.

Fascinatingly, promising preliminary studies designed by Duckworth and colleagues (2013) have begun to conduct cross-sectional studies of school-age children investigating the link between having an incremental implicit theory of intelligence and grit. Early findings point towards a moderate, positive association between grit and having an incremental implicit theory of intelligence, and "may contribute to the tendency to sustain effort toward commitment to goals" (Duckworth & Eskreis-Winkler, 2013). Investigating the relationships between medical students' ITI and grit has the potential to provide similar insights into furthering our understanding of the complex nature of these students, and the ways our developing physicians set, maintain, and remain dedicated to their commitment to learning anatomy.

CHAPTER 3: METHODS

The central aim of this study was to answer the following research question: What are the relationships between medical students' beliefs about intelligence and grittiness, in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy? This led to a better understanding of the relationships between medical students' implicit theories of intelligence (ITI), level of grit, and the individual self-regulatory processes involved in learning gross anatomy; specifically the self-regulatory processes of goal setting (setting performance goals versus learning goals), goal operating (having helpless versus mastery-oriented operational strategies), and goal monitoring (the process of examining one's progress with negative emotions versus having optimistic expectations). This study utilized a two-phase, sequential explanatory mixed methods case study research design; the mixed methods case study design consisted of two distinct phases: a quantitative phase followed by a qualitative phase (Creswell, 2009; Creswell & Plano-Clark, 2011). First, the quantitative phase one explored and measured medical students' ITI and level of grit; the results from phase one then informed and provided a foundation for the second phase of the study which qualitatively explored medical students' self-regulatory processes in learning gross anatomy.

The primary sources of data for this study were survey results collected from the Implicit Theory of Intelligence Scale (ITIS) survey (Dweck, 2000), data collected from the Short Grit Scale Survey (Duckworth et al., 2007), and data collected from in-depth one-on-one interviews conducted with medical students who had completed their gross anatomy course requirement. The use of a two-phase, sequential explanatory mixed methods case study research design was key, as this research design combines the strengths of a case study approach, with both quantitative and qualitative methods of data collection and analysis. The rationale behind using a mixed methods design is that it allows the researcher to address more complex research questions than can be accomplished by any single method alone. This particular methodology provided a framework to more fully understand the ITI, and grit of medical students, their self-regulatory processes, and the relationships between these areas (Yin, 2009). This chapter offers detail on the philosophical underpinnings, mixed methods case study procedures, and approach to data collection and analysis that were used. The chapter concludes with a discussion of the ethical and trustworthiness considerations for the study.

Mixed Methods Case Study Approach

A mixed methods approach draws upon the strengths of both quantitative and qualitative research; it considers multiple viewpoints, positions, perspectives, and standpoints (Johnson, Onwuegbuzie, & Turner, 2007). This methodology uses one type of approach to better understand and build on results from the other, all in order to broaden understanding and address the complex issues present in social and human sciences (Creswell, 2009). Furthermore, "this form of research is more than simply collecting both quantitative and qualitative data; it indicates that data will be integrated, related, or mixed at some stage of the research process," following the logic that neither qualitative or quantitative methods are sufficient by themselves to "capture the trends and details of the situation" (Creswell, Fetters, & Ivankova, 2004, p. 7). Furthermore, using a case study design in a mixed methods study is advantageous because according to Yin (2012), one rationale for conducting a case study is when there is "a desire to derive an

[up]-close or otherwise in-depth understanding of a single or small number of cases," intending to "go beyond the study of isolated variables," and address the "what is happening" and "how did something happen" aspects of the case study (p. 4). This philosophical orientation was key to this study, as a mixed methods case study approach allowed the researcher the opportunity to inquire into, and quantitatively measure the ITI and grit of medical students; while also attempting to understand the experiences of medical students through a qualitative exploration of the self-regulatory processes used in learning gross anatomy. This study was intentionally chosen as the design provided a framework upon which to most effectively explore the relationships between ITI, grit, and the self-regulatory processes of medical students.

The idea of using mixed methods is not a new one. In 1959, Campbell and Fiske introduced the idea of triangulation, more specifically, how using more than one method could be part of a validation process to ensure that findings were not a result of the method used (Campbell & Fiske, 1959). Almost immediately, others suggested that using two or more methods would enhance "our beliefs that the results [were] valid and not a methodological artifact" (Bouchard, 1976, p. 268). As time progressed, the ideas of Campbell and Fiske expanded, and in 1978 Denzin first outlined how to triangulate methods, through triangulation of data, investigator, theory, and methodology (Johnson et al., 2007). Denzin contended that, "the bias inherent in any particular data source, investigators, and particular method will be cancelled out when used in conjunction with other data sources, investigators and methods" (Denzin, 1978, p. 14).

Eventually, researchers began to provide reasons not only for triangulation, but reasons to combine quantitative and qualitative research (Sieber, 1973). Citing three reasons to combine the two types of research: first, it would enable confirmation or corroboration of the other through triangulation; second, it would allow for the development of analysis to provide data that was richer; and finally, it would initiate new types of thinking by examining the paradoxes that emerge from both data sources (Rossman & Wilson, 1985). More recently, Collins, Onwuegbuzie, and Sutton identified four reasons to combine these two types of research, which were: participant enrichment, instrument fidelity, treatment integrity, and significance enhancement (2006). Overall, mixed methods research can be defined as,

> The type of research in which a researcher or team of researchers combine elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration. (Johnson et al., 2007, p. 123)

It offers a significant and focused approach for "generating important research questions and providing warranted answers to those questions" (Johnson et al., 2007, p. 129).

In the field of medical education, mixed methods research is also not new. For example, over 15 years ago, authors in primary care introduced how important integrating quantitative and qualitative methods of research into a single study could be in order to make advances in patient care (Blake, 1989). More recently, Evans and Benefield (2001) stressed the importance of using mixed methods in medical education research, citing that the emphasis on evidence-based practice alone threatens to "reduce research questions to the pragmatics of technical efficiency and effectiveness. It will not encourage research which explores the wider social, philosophical or ethical issues" (p. 539). In 2004, Borkan suggested that a mixed methods approach should be a foundation for all primary care research, stating that the methods together "suggest, discover, and test hypotheses;

they give new insights on complex phenomenon; they allow the investigator to address practice and policy issues from the point of view of both numbers and narratives; they add rigor" (p. 4). Finally, in 2009, Schifferdecker and Reed published an article providing basic guidelines for researchers wanting to use mixed methods in medical education research. They claimed, "Both qualitative and quantitative approaches [were] needed to expand knowledge and understanding of educational process and content and of impacts" (Schifferdecker & Reed, 2009, p. 638). They concluded that, "mixed methods research may offer a number of benefits over purely qualitative or quantitative approaches…[and] in medical education research, mixed methods approaches may prove superior in increasing the integrity and applicability of findings" (Schifferdecker & Reed, 2009, p. 642).

The mixed methods sequential explanatory case study design in this study consisted of two distinct phases: a quantitative phase followed by a qualitative phase (Creswell, 2009; Creswell & Plano-Clark, 2011). In phase one, the researcher utilized two quantitative surveys, in order to collect and analyze data. This quantitative data was then used to inform and guide the subsequent qualitative component of the study, which was phase two. Specifically, the researcher used the quantitative data to refine the qualitative components and inquiry, including using the data from the quantitative phase to conduct purposeful sampling for the qualitative phase of data collection (Creswell & Plano-Clark, 2011). Finally, the qualitative, or second phase of this study was crucial in that it allowed the researcher to explore findings from phase one and begin to understand participants' experiences and views in more depth. As Creswell (2007) contended, it is appropriate for researchers to adopt qualitative approaches because:

> We need a complex detailed understanding of an issue...[and] this detail can only be established by talking directly with people…and allowing them to tell the stories unencumbered by what we expect to find or what we have read in the literature. (p. 40)

The two-phase, sequential explanatory mixed methods case study design of this study was advantageous for four reasons. First, this type of study design is straightforward to implement, and due to the fact that the second qualitative phase is designed, guided, and based on what is learned from the first phase, it lends itself well to the flexibility of an emergent design. An emergent design in qualitative research is a theme of inquiry where the "researcher avoids getting locked into rigid designs that eliminate responsiveness and pursues new paths of discovery as they emerge" (Patton, 2002, p. 40). This study design allowed for the questions asked, and even working hypotheses in phase two to evolve in response to what was learned from phase one and as the study progressed; essentially, the "process of data collection and analysis is recursive and dynamic" (Merriam, 2009, p. 237).

Second, in order to answer the primary research question of this study the researcher needed to quantitatively measure the implicit theories of intelligence that medical students held, as well as medical students' level of grit. In order to do this, two quantitative surveys were used in phase one. The first survey was based upon Dweck's Implicit Theory of Intelligence Scale (ITIS) survey and was used in order to identify the structure of participants' implicit theory of intelligence (ITI) (2000). The second survey, called the Short Grit Scale Survey, was first modeled by Duckworth and colleagues (2007), and quantitatively measured the perseverance and passion, otherwise referred to as grittiness that an individual has, for long-term goals. This quantitative component played a key role in discovering the ITI of medical students and subsequently the degree to which participants considered intelligence fixed or malleable; in addition, it allowed the researcher to measure participants' grittiness.

Third, in order to understand and explore the self-regulatory processes that medical students use in gross anatomy, 25 qualitative one-on-one interviews were conducted. This was the second phase of the study, and provided a platform on which to deeply explore the complex interactions between ITI, grit, and learning behaviors—issues that were too multifaceted to be studied sufficiently with survey analysis alone. Qualitative interviews have the ability to capture the complexity surrounding the goal setting, goal operating, and goal monitoring that occur in relation to medical students' different implicit views on intelligence and grittiness. This phase provided a greater understanding of the impact, interaction, and even influence, that ITI and grit have on learning anatomy; which becomes especially important as research has shown that ITI and grit are important in how an individual sets goals, confronts challenges, and even responds to difficulty (Dweck & Grant, 2008). Qualitative data was collected in order to expand our understanding of the anatomical learning gaps seen in medical students; an understanding that has implications for the changing anatomical classroom, in that it can provide insight into areas where curriculum could be effectively strengthened.

Fourth, this study desired to understand how the implicit theories of intelligence (ITI) and grittiness of medical students influenced, interacted, and impacted their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy—essentially how did the quantitative results relate to and inform the gathering of and findings specific to the qualitative phase? This was why a sequential explanatory mixed methods case study design was used, as it allowed the researcher to bring the quantitative and qualitative components of this study together most meaningfully upon completion of each phase; allowing the researcher to most effectively illuminate the relationships between medical students' beliefs about intelligence and grittiness, in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy.

In summary, medical students are situated at the center of the complex world of undergraduate medical education (UME), and as such, their experiences and perspectives are influenced by the context in which they are placed. Creswell (2007) asserts that qualitative research is conducted when we want to "understand the contexts or settings in which participants in a study address a problem or issue" (p. 40). This philosophical orientation was an important key to this study because the context and setting in which medical students attempt to lay their anatomical knowledge foundation for their future roles as residents, then later as an independent physicians, have direct consequences on learning. Medical students are individuals deeply immersed, at various stages, in the process of using their knowledge in ways never previously encountered, or demanded of them. While this study did not explore quantifiable measures that prove or disprove the presence of anatomical knowledge, it did examine how different ITI and levels of grit impact key self-regulatory processes involved in learning anatomy.

Research Design

Overview

The aim of this study was to examine the relationships between medical students' beliefs about intelligence and grittiness, in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy. Thus, a two-phase sequential explanatory mixed methods case study design was carried out to most effectively address the study's aim. First, the quantitative (Implicit Theory of Intelligence Scale survey and Short Grit Scale Survey) surveys were administered and data was collected (n=382/999) to identify medical students' beliefs about intelligence and their grittiness. This approach allowed for the researcher to purposefully select individuals for the subsequent qualitative data collection phase. The second data collection phase used in-depth one-on-one semi-structured interviews (n=25) to explore medical students' self-regulatory processes in the course of learning anatomy. Figure 3.1 provides a visual model and timeline for the two-phase sequential explanatory mixed methods case study design that was used in this study. Even though mixed methods research poses a unique set of challenges, including extensive data collection, and the time-commitment to analyze two different types of data, it has great potential.

Figure 3.1: Timeline and Progression of Study

Phase[1]	Procedures	Timeline
QUAN Data Collection	▪ Implicit Theories of Intelligence Scale Survey ▪ Short Grit Scale Survey ▪ Demographics	August - October, 2014
QUAN Data Analysis	▪ Descriptive Analysis of Demographics ▪ Implicit Theory of Intelligence and Grit Score Analytics	September - October, 2014
Connecting QUAN and QUAL Phases	• Purposeful, systematic selection of participants from Phase 1 for Phase 2	September - October, 2014
QUAL Data Collection	▪ In-depth one-on-one interviews	October - November, 2014
QUAL Data Analysis	▪ Coding and thematic analysis ▪ Constant comparative analysis of data	December, 2014 - January, 2015
QUAN + QUAL = Results	▪ Interpretation, and explanation of relationship between quantitative and qualitative data results	January - February, 2015

[1]Figure 1. Based on the visual model of study phase progression, procedures and timeline (Ivankova, Creswell, & Stick, 2006; Creswell & Plano-Clark, 2007).

Phase One: Quantitative Methods

This section outlines the specific details of phase one of this study, including a description of the participants, sampling measures, data collection methods, and concludes with the data analysis that was used. The purpose of the quantitative portion of the study was fourfold: (1) to identify the ITI that medical students hold, (2) to identify medical students' level of grit, (3), to identify the relationship(s), if any, between medical students' ITI, and grit, and (4) to identify participants for phase two of the study.

Participants

The participants in this study (n=382/999) were medical students who fulfilled two requirements: (1) participants were currently enrolled in any of their four years of undergraduate medical education, and in good academic standing at any of the nine regional campuses of the Indiana University School of Medicine (IUSM) (Bloomington, Evansville, Fort Wayne, Indianapolis, Lafayette, Muncie, Northwest, South Bend or Terre Haute); and (2) participants had completed and passed their medical gross anatomy coursework. All who met these two requirements were invited to participate. Efforts were made to gather a population diverse in ethnicity and demographic characteristics.

Sampling

Sampling for this study was purposeful and strategic. Purposeful sampling "is to select information-rich cases whose study will illuminate the questions under study" (Patton, 1990, p. 169). As such, the researcher employed the strategy of criterion sampling to pick medical student participants, using the aforementioned two criteria for participation. Criterion sampling is where "sampling is to review and study all cases that meet some predetermined criterion of importance" (Patton, 1990, p. 176). By focusing on one specific medical school (IUSM), this case study was intentionally bounded by participant (medical students in year two, three, or four), place (IUSM), and activity (students must have competed their gross anatomy requirement).

The choice of bounding the study by place is deliberate, as IUSM has multiple campuses that offer rich variation in the student population and experience; with 999 students that met the study's two requirements. As such it provided a large, diverse, yet manageable population of medical students from which to draw. The multiple campuses were especially advantageous as each of the nine locations have different class sizes, different gross anatomy instructors, and variations within their curriculum that offer an assorted set of backgrounds and environments that participants have learned anatomy within. In this way, findings were less attributable to one particular professor or specific campus environment, and more focused on the student's ITI, grit, and diverse self-regulatory behaviors of the anatomical learner.

Data Collection and Survey Instrument

The first portion of the two-phase sequential explanatory mixed methods case study design was the administration of a quantitative survey to all medical students currently in good academic standing, that have completed their gross anatomy requirement, and who were second, third, or fourth year medical students at any of the nine IUSM campuses (n=999). The survey consisted of two components: (1) Dweck's Implicit Theories of Intelligence Scale (ITIS) survey (See Appendix A), which is a survey that determined participants' implicit theory of intelligence and assessed the degree to which a participant considered intelligence fixed or malleable; and (2) the Short Grit Scale Survey (See Appendix B), which quantitatively measured the perseverance and passion, otherwise referred to as grittiness, that an individual has for long-term goals. Furthermore, gross anatomy grade and demographic information was collected as self-reported information in this survey; demographics collected included gender and the participants' year in medical school. At the end of the survey, students were asked if they would be willing to participate in phase two of the study, informing them that phase two consisted of an in-depth interview with the intent to explore how they personally set, acted on, and monitored their goals while learning gross anatomy. The participants were also notified that if they chose to participate in phase two of the study, the interview would last approximately 30 minutes, and would take place at a time and location of their choosing; and that if selected to participate, they would be contacted via e-mail to schedule the interview.

ITIS Survey Instrument

The implicit theories of intelligence scale was originally develop in 1989 by Dweck and Henderson, and included a three-item scale that assessed whether an individual believed intelligence was fixed (entity theory) or malleable (incremental theory); where higher scores indicated an entity view of intelligence (Deemer, 2004). Eventually, the survey grew to include eight items, and the items were recoded so that a higher score on the survey indicated an incremental theory of intelligence instead. Currently, the scale (Appendix A) uses a six-point Likert scale ranging from one (strongly agree) to six (strongly disagree), and consists of the following eight questions:

1. You have a certain amount of intelligence, and you can't really do much to change it.
2. Your intelligence is something about you that you can't change very much.

3. No matter who you are, you can significantly change your intelligence level.
4. To be honest, you can't really change how intelligent you are.
5. You can always substantially change how intelligent you are.
6. You can learn new things, but you can't really change your basic intelligence.
7. No matter how much intelligence you have, you can always change it quite a bit.
8. You can change even your basic intelligence level considerably.

Respondents indicate their degree of agreement or disagreement with each of the item statements; and point values for incremental theory question items (numbers 3, 5, 7, and 8) are reverse coded and scored. This resulted in higher final scores indicating individuals who were incremental theorists and lower final scores indicating individuals who were entity theorists.

The survey has been validated through numerous studies, with Cronbach's Alpha values that range from 0.94 to 0.98, indicating high internal consistency (Dweck, 2000). The ITIS survey has also been shown to have high test-retest reliability over a two-week period, suggestive of its stability in its appraisal of theories about intelligence (Deemer, 2004). Finally, the implicit theories of intelligence scale has been shown to be distinct from measures of cognitive ability, self-esteem, and confidence in intellectual ability, through discriminant validity studies (Deemer, 2004).

Short Grit Scale Instrument

The short grit scale was first modeled by Duckworth and colleagues (2007) at the University of Pennsylvania, and is a survey to quantify grit on a scale from one to five. The short grit scale version (Appendix B) was used in this study, and consisted of the following eight questions:

1. New ideas and projects sometimes distract me from previous ones.
2. Setbacks don't discourage me.
3. I have been obsessed with a certain project for a short time but later lost interest.
4. I am a hard worker.
5. I often set a goal but later choose to pursue a different one.
6. I have difficulty maintaining my focus on projects that take more than a few months to complete.
7. I finish whatever I begin.
8. I am diligent.

The survey uses a five-item Likert scale ranging from one (low or not like me at all) to five (high or very much like me) for each question response. The derivation of each participant's grit score is done by averaging point values for each of the "high-grit" questions (numbers 2, 4, 7, and 8 above) with the average of the Likert scale's inverse value for "low-grit" questions (numbers 1, 3, 5, and 6 above). For example, if a participant gave a response of 1 to a low-grit question, this is scored as 5, a response of 2 is allotted 4 points, and so on. Once adjusted, all points are then added up and divided by eight. The maximum total score on this survey is five, indicating somebody who is extremely gritty, and the lowest possible total score is one, indicating somebody who is not gritty at all. Evidence has shown that the short grit scale instrument has internal consistency, test-retest stability, and predictive validity as an "economical measure of perseverance and passion for long-term goals" (Duckworth & Quinn, 2009, p. 174).

Data Analysis

The primary research question for this study required that the researcher determine the ITI and level of grit of each medical student participant. As such, the numeric totals associated with each of the quantitative survey components were calculated using Microsoft Excel, with each participant earning one score for their ITI (directly representative of the implicit theory of intelligence they held), and one numeric score for their level of grit.

The researcher performed statistical analysis using Statistical Analysis Software (SAS) version 9.4 to determine if any relationship existed between ITI and level of grit (SAS Institute Inc., 2014). Several statistical tests were used to examine these relationships, including independent samples *t*-tests, Pearson's correlations, multiple linear regression, and ANOVA analysis. The information gathered provided core direction and framework for the further investigation that occurred in phase two of the study, and established the four groups of analysis: individuals who were entity theorists with a high grit score (HE), individuals who were entity theorists with a low grit score (LE), individuals who were incremental theorists with a high grit score (HI), and individuals who were incremental theorists with a low grit score (LI). Information also provided a context in which to explore medical students' self-regulatory processes in the course of learning anatomy. In addition, analysis of other variables and their relationship(s) to ITI and grit occurred during phase one, including examination of: course grade analysis, and categorical demographic variable analysis (gender, year in medical school) in order to determine any existing underlying relationships.

Phase Two: Qualitative Methods

Participant Selection

Participant selection for phase two of this study stemmed directly from phase one. With a sequential explanatory mixed methods case study design, the individuals that participated in the second qualitative phase also had participated in the first quantitative phase (Creswell & Plano-Clark, 2011). The participants were individuals who were asked at the conclusion of the survey in phase one of the study if they would be interested and willing to participate in an in-depth one-on-one interview to explore how they personally set, acted on, and monitored their goals while learning gross anatomy in medical school. The researcher chose individuals with variable demographics and grade performances in gross anatomy, who fell within one of the following four categories: individuals who were entity theorists with a high grit score, individuals who were entity theorists with a low grit score, individuals who were incremental theorists with a high grit score, and individuals who were incremental theorists with a low grit score; resulting in interviewing 25 individuals total, with six to seven individuals from each category. The participants were chosen only from those medical students who self-selected to participate, on a first response, first invitation basis. Meaning, as surveys from phase one were completed and each participant emerged with an ITI category and grit score, those interested in being interviewed were contacted immediately and invited to participate. This continued until the researcher reached the desired number of participants for each of the aforementioned categories.

Data Collection

Data collection consisted of the researcher conducting a series of semi-structured, in-depth, one-on-one qualitative interviews (n=25). The interviews were approximately 30 minutes in length, and conducted over a period of two months. The goal of the in-depth interviews was to capture the "richness" of the medical students' self-regulatory processes in context of their ITI and grittiness in learning gross anatomy (Rubin & Rubin, 1995, p. 76). The researcher conducted 25 one-on-one interviews total, aiming to have an equal mix of medical students who were entity theorists and those who were incremental theorists, as well as those who were highly gritty and those who had low grit. The manageable number of interviews is an approximate, for as Patton (2002) stated, the "validity, meaningfulness, and insights generated by qualitative inquiry have more to do with the information richness of the cases selected and the observational/analytical capabilities of the researcher than with sample size" (p. 245). As such, the researcher felt 25 interviews were necessary to ensure saturation of findings.

The researcher conducted the semi-structured interviews like a conversation, encouraging participants to speak-up freely, but abided by a general interview guide (Appendix C) (Yin, 2009). The semi-structured interview guide included open-ended questions, allowing participants to articulate their perceptions and experiences spontaneously and freely. This structure also allowed the researcher to explore and probe the participant concerning findings as they emerged, reflecting the use of an emergent design during data collection. With an emergent design, the study itself, questions asked, and even working hypotheses, evolve in response to what is learned as the study progresses; essentially, the "process of data collection and analysis is recursive and dynamic" (Merriam, 2009, p. 237). It is a design that "unfolds or emerges as fieldwork unfolds…[trusting] in the ultimate value of what inductive analysis will yield" (Patton, 2002, p. 44).

Specifically, during the interviews, participants were asked about their goal setting, goal operating, and goal monitoring processes in learning gross anatomy during medical school. Goal setting questions explored the types of, and details surrounding, the goals the medical student set for themselves in gross anatomy (performance or learning goals), and why these goal were important to them. While goal operating questions explored how medical students reacted to difficult situations while learning gross anatomy (helpless or mastery-oriented reactions). Finally, goal monitoring questions explored how medical students emotionally evaluated their potential for goal success as they progressed throughout the semester (reporting negative emotions or optimistic expectations). See Appendix C for a list of general interview questions. The purpose of these open-ended questions was to better understand the lived experience of the medical student in context of their ITI, grittiness, and the meaning they made of those experiences (Seidman, 2006). Interviews were audio recorded with permission of the participants, and were transcribed verbatim. All participants' responses remained confidential.

Data Analysis

The purpose of this phase of the study was to explore how self-regulatory behaviors impacted the process of learning gross anatomy and how one's ITI and grittiness played a factor in this process. Data analysis commenced with the researcher transcribing the recorded interviews verbatim. During transcription of the interviews, the researcher took notes, and kept record of any personal impressions or reactions to the data in a separate database throughout the transcription process. This provided documentation of the researcher's thoughts and potential biases during the ongoing analysis process.

Pre-defined thematic categories were not used in this process, but rather, categories related to findings emerged as analysis proceeded. Categories of meaning, with the relationships between categories being derived from the data itself through a process called inductive analysis. Inductive analysis is used to build patterns and themes from data collected in the study (Patton, 2002; Creswell, 2009). Key statements were highlighted and categorized into general themes, and to arrive at conclusions, analysis was completed using principles of a constant comparative approach where the researcher coded and simultaneously compared the data, reflected upon it, reduced it, and then repeated the process until saturation was achieved (Glaser and Strauss, 1967). Coding is a process where "incidents or issues with similarities are grouped together into themes or categories, which are named according to meaning," an ongoing process that occurred throughout the study that examined connections both within and between individual cases (Kennedy and Lingard, 2006, p. 104).

Stated another way, a constant comparative approach "offers the means whereby the researcher may access and analyze [the] articulated perspectives so that… with each important finding" the data is being constantly compared with other findings for similarities and differences, with the intent to generate initial categories, or coded themes of importance in the data (NVivo Training, 2012). Furthermore, this process involved breaking the data down into discrete incidents (Glaser & Strauss, 1967), or units (Lincoln & Guba, 1985); after which, the categories underwent content and definitional changes as findings and incidents were compared and categorized. As understanding of the coded themes and the relationships between findings were developed and refined over the analysis process, the researcher was able to saturate the categories of findings—until analyzing new data did not yield any additional insight, meaning, or uniqueness to the study's findings (Creswell et al., 2007).

Integration of Quantitative and Qualitative Data

There are two major points in this study where quantitative and qualitative data were mixed, and strengthened the case of the other. First, quantitative findings were used from the survey data collected in phase one to categorize and assist in participant selection for phase two; and quantitative findings helped to illuminate relationships that existed between ITI and grittiness, which were further explored during the individual interviews. Second, once the qualitative data was collected and analyzed from the in-depth interviews, findings were related back to the implicit theories of intelligence and grittiness that were measured in phase one. This specifically allowed the researcher to explore the relationships between medical students' ITI, grit, and the qualitative themes that emerged related to the self-regulatory processes uncovered in phase two.

Research Permission, Ethical and Trustworthiness Considerations

The Institutional Review Board (IRB) at Indiana University reviewed the protocol and granted approval to conduct the study (Study number 1408883334). All study data was stored electronically on a secure, password-protected server. In addition, by using a mixed methods design, part of which is qualitative in nature, the researcher knew it prudent to ensure the quality, reliability, and validity of the study. In order to do this the researcher did the following three things: (1) clarified personal researcher bias, (2) used member checking, and (3) presented thick descriptions of findings.

Clarifying researcher bias. In clarifying the personal biases and experiences of the researcher, it allows insight into why the study was designed as it was, and how data was interpreted. As such, the researcher notes that she has experiences with medical gross anatomy at IUSM, having personally taken the course at this institution, tutored students in the course, and has also taught in the course. Furthermore, the researcher believes that intelligence is largely a malleable trait, and that how an individual self-regulates their individual learning behavior is intricately connected to one's implicit theory of intelligence; believing that this has the potential to impact the depth and way in which one learns. In addition, the researcher discussed biases and findings with her graduate committee co-chairs in order to develop a greater awareness of how her biases could have influenced data analysis, interpretation, and presentation.

Member checking. According to Creswell, member checking involves the researcher soliciting the participants' views of the credibility of the findings and interpretations of the data (2009). As such, the researcher took data collected during phase two of the study back to the participants from whom it was collected in order to confirm the plausibility and conclusions drawn from the data. In particular, the interviewee was given the chance to examine their transcript from the one-on-one interviews in order to determine the accuracy and credibility of the account that was given and recorded.

Thick descriptions of findings. It is expected in qualitative research that rich descriptions with authentic participant quotes be given in the analysis, interpretation, and presentation of findings. The researcher did this in order to ensure she provided context of how conclusions were made, how findings reflected the situation being investigated, and also so that the researcher could assist the reader in better understanding the setting in which the findings occurred (Creswell, 2009).

CHAPTER 4: RESULTS

The intent of this two-phased sequential explanatory mixed methods case study was to examine medical students' ITI and grit in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy. In phase one, quantitative research questions addressed three areas: (1) the ITI that medical students held; (2) medical students' level of grit; and (3) the relationships between medical students' ITI and grit while considering the variables of gender, year in medical school, and grade performance in gross anatomy. In addition, this phase identified participants who volunteered to participate in phase two of the study.

In the second phase of the study, semi-structured, in-depth, one-on-one qualitative interviews were conducted to explore how medical students set goals, operated while reaching those goals, and monitored their progress in achieving those goals, all in the context of their ITI and grittiness in learning of gross anatomy. Specifically, the following research question outlined and guided the study, "What are the relationships between medical students' beliefs about intelligence and grittiness in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy?" This was asked in order to explore the ITI held by medical students, their grittiness, how ITI and grit interacted, and more importantly, how the individual self-regulatory processes involved in learning gross anatomy was impacted by ITI and grit.

This chapter is divided into a quantitative part and a qualitative part. Both parts of the chapter report findings pertinent to the main research question. A description of the participants for the quantitative and qualitative phases precedes the findings for each section. In part one of this chapter I present the quantitative findings concerned with the identification of medical students' ITI, and grit, and explore the relationship between these two variables while accounting for differences in the participants' gender, year in medical school, and academic performance in gross anatomy. This was accomplished by collecting data using Dweck's Implicit Theories of Intelligence Scale, Duckworth's Short Grit Scale, students' academic performance in gross anatomy, and limited demographic information. The data generated from the administered quantitative survey reflects an overall picture of the medical students' beliefs about intelligence, grittiness, and their performance in gross anatomy.

In part two of this chapter I present the qualitative findings concerned with understanding how medical students' ITI and grit influence the ways they set goals, operated in the midst of those goals, and monitored their progress in achieving those goals. To accomplish this, the researcher conducted 25 in-depth, one-on-one qualitative interviews with systematically selected participants. The interviews were conducted with an open-ended interview question guide (Appendix C), and were transcribed verbatim. Interviews were analyzed using principles of a constant comparative analysis where the researcher coded, and simultaneously compared the data, reflected upon it, reduced it, and then repeated that process until saturation was achieved. This generated multiple categories of analysis and by comparing it with similarly coded data, the researcher was able to identify central themes relating to the research question.

PART ONE: QUANTITATIVE RESULTS

Data Screening

The quantitative phase of this study required several statistical techniques including independent samples *t*-tests, Pearson's correlations, multiple linear regression, and ANOVA analysis. All statistical analyses were conducted using SAS® software, Version 9.4 of the SAS System for Indiana University (SAS Institute Inc., 2014).

Before conducting any statistical analyses, the data were examined to ensure that the assumptions of these statistical tests were fully met. For independent samples, a *t*-test assumes that the data are approximately normally distributed, there are no significant outliers in the dataset, and that the variance is equal between the two groups being compared. In addition, Pearson correlation also assumes a normal distribution of the data and that a linear relationship exists between the two variables. Upon visual inspection of the normal probability plots and histograms of the independent variables of year in medical school and grade performance, an approximately normal distribution was revealed. The normal distribution of the independent variable concerned with grade performance is in line with the fact that the researcher used criterion sampling to pick participants. This required that medical students had to have successfully completed their gross anatomy requirement with a grade within the 70-100% range to participate, and that those who failed the course were not invited to participate.

When conducting an independent samples *t*-test, SAS software tests for homogeneity of variance using the folded form F statistic. If the F statistic is significant, the assumption of homogeneity of variance is violated, and equal variances between the two groups cannot be assumed. By default, SAS reports the *t*-values for two different versions of the independent samples *t*-tests: one assuming equal variances (Pooled), and the other not assuming equal variances (Satterthwaite). For those variables with a significant folded form F statistic, the Satterthwaite *t*-value was reported, interpreted, and used (Satterthwaite, 1946).

Participants

Quantitative data collection occurred between August 2014 and October 2014. A total sample size of 278 students was needed in order to achieve adequate statistical power (Faul, Erdfelder, Buchner, & Lang, 2009). Within the quantitative strand, 428 of the 999 administered surveys were returned. Of these, 46 were deleted due to missing values or incomplete responses, which resulted in a total of 382 completed, returned surveys. Fifty percent of the quantitative strand participants were female, and 50% male. Forty percent (n=152) identified as second year medical students, 26% (n=100) identified as third year medical students, and 34% (n=130) identified as fourth year medical students. First year students were not invited to participate, due to the fact that at the time the study was conducted they had not yet completed their gross anatomy course requirement. Approximately 18% of participants achieved an honors grade in gross anatomy (an honors final grade roughly encompassed final percentage points between 95-100%), 47% achieved a high pass grade (a high pass final grade roughly encompassed final percentage points between 88-94%), 35% achieved a pass grade (a pass final grade roughly encompassed final percentage points between 70-87%), and 0.5% did not wish to indicate a response. A more detailed description of the quantitative strand participants is provided in Table 4.1.

Table 4.1

Description of Quantitative Strand Participants

Variable	*n*	%
Sex		
Female	192	50.3
Male	190	49.7
Year in Medical School		
1	0.0	0.0
2	152	39.8
3	100	26.2
4	130	34.0
Final Grade Earned in Gross Anatomy[1]		
Honors	69	18.1
High Pass	179	46.9
Pass	132	34.6
Would Not Disclose	2	0.52

(n=382)

[1] Note: An honors grade is approximately equivalent to a final grade percentage of 95-100%, a high pass grade is approximately equivalent to a final grade percentage of 88-94%, and a pass grade is approximately equivalent to a final grade percentage of 70-87%.

Scoring and Cutoffs

Given that medical students are, typically, highly motivated individuals that have chosen to undertake a stressful path to professional success, consideration was given to how their grit scores would be analyzed. The median grit score (50th percentile) of the general United States population is approximately 3.4 (Burkhart et al., 2014), while this study found medical students to have a median grit score of 3.75. Because the researcher intended to consider the grit of medical students relative to other medical students, within the domain of medical school, and not to the general population, high versus low grit score cutoffs were not decided based on the national median or mean (Duckworth & Quinn, 2009). Rather, given this context, and the uniqueness of this population, during analysis it was deemed more appropriate to use the median split in the medical student population as the division point between high and low grit. Thus, this resulted in students with grit scores of 3.75 and above to be considered highly gritty. Conversely, those students with a grit score of 3.74 and below were considered to have low grit.

As for ITI, the literature often cites a hard cutoff of four and above to designate those who hold an incremental theory of intelligence, while a score of three and below designates an individual considered to have an entity theory of intelligence (Dweck, 2000; Deemer, 2004). In addition, those with scores between three and four are often thrown out of analysis (Deemer, 2004). However, the literature is not consistent and suggests examining your population of interest and considering retaining individuals that fall in the middle range of the scale, if of interest (Deemer, 2004). Thus, for the purposes of this study, the median medical student score of 3.5 was used as the division point between those with an incremental versus an entity theory of intelligence, and no scores were thrown out. Subsequently, students with an ITI score of 3.5 and above were considered to be incremental theorists, while those with an ITI score of 3.4 and below were considered to be entity theorists. A more detailed description of the ITI and grit statistics can be found in Table 4.2.

Table 4.2

ITI and Grit Variable Statistics

	n	%	Mean	Median	*SD*	Min	Max
ITI (Overall)	**382**	**100**	**3.51**	**3.5**	**1.04**	**1**	**6**
Entity	200	52.4					
Incremental	182	47.6					
Grit (Overall)	**382**	**100**	**3.55**	**3.75**	**0.60**	**1.63**	**4.75**
High Grit	183	47.9					
Low Grit	199	52.1					

Finally, it is important to clarify that for both of the variables, grit and ITI, analysis was completed using both dichotomous variables (high grit (HG) versus low grit (LG), and entity (E) versus incremental (I) theorist) as well as continuous variables. For grit, the continuous variable option was the calculated raw grit score; and for ITI, the continuous variable option was the calculated raw ITI score.

Grades

Analysis of grades was performed in one of two ways: first, grades were examined and analyzed as raw percentages; and second, grades were collapsed into two major categories for additional analysis. The way grade percentages were collapsed included those with an honors or high pass grade (88-100%) being collapsed into one group (called the high grade group), while the other group consisted of those who had earned a pass grade (70-87%) (called the low grade group). The two major categories, high grade group versus low grade group, had 246 (64.4%) of individuals falling into the high group, and 136 (35.6%) of individuals falling into the low group.

Gender

A Pearson chi-square test is a test used to determine whether an association exists between two independent random variables. In this case, a Pearson chi-square test indicated that gender was not significantly associated with whether an individual was an entity or incremental theorist, X^2 (1, n=382) = 0.92, $p > 0.05$. This was not an unexpected finding, as previous research has indicated that while age and experience are important predictors of one's beliefs about intelligence, sex is not (Georgiou, 2008; Jonsson, Beach, Korp & Erlandson, 2012). This also held true with respect to grit, namely, a Pearson chi-square test failed to indicate that gender was significantly associated with whether an individual was highly gritty or had low grit, X^2 (1, n=382) = 0.68, $p > 0.05$.

Year in Medical School

The researcher conducted an ANOVA test to determine if mean raw grit score and mean raw ITI score were significantly different among the second, third, and fourth year medical students. There were no significant differences in either grit or ITI scores among the three different year groups of participants.

Implicit Theories of Intelligence

The researcher conducted an independent sample *t*-test to determine if mean grade percentages earned in gross anatomy were significantly different for entity (E) versus incremental (I) theorists. The *t*-test showed no significant differences in grade percentages between E and I groups, with a *t*-value -0.34 ($p = 0.57$). Entity theorists' average grade was 85.0 percent, and incremental theorists' average grade was 85.2 percent. Examination of grades as a dichotomous variable (high grade versus low grade groups) was also conducted. A Pearson chi-square test indicated that grade group was also not significantly associated with one's ITI, X^2 (1, n=382) = 0.15, $p > 0.05$.

Grit

The researcher conducted an independent sample *t*-test to determine if mean grade percentages earned in gross anatomy were significantly different for high grit (HG) and low grit (LG) individuals. The *t*-test showed variances between the two groups were not equal, so an adjusted Satterthwaite interpretation was used, which showed a significant difference in grade percentages between HG and LG individuals, with a *t*-value of 9.82 ($p < 0.0001$). Highly gritty individuals averaged 88.3 percent, and those with low grit averaged 82.2 percent in the class. Examination of grades as a dichotomous variable (high grade versus low grade groups) was also conducted. A Pearson chi-square test indicated that grade group was significantly associated with one's grittiness X^2 (1, n=382) = 53.36, $p < 0.0001$. The odds ratio was 5.48, 95% CI [3.40, 8.82], indicating that there is an increased likelihood, by a factor of 5.48, of being in the high grade category (88-100%) if you have high grit.

Implicit Theories of Intelligence and Grit

In this section, findings from multiple statistical tests are discussed, including the tests that were used to analyze and address one part of the main research question, namely: What are the relationships between medical students' beliefs about intelligence and grittiness?

Independent Samples t-tests

Using high grade versus low grade performance categories as units of analysis, a series of independent *t*-tests was conducted. The *t*-tests showed a statistically significant difference in the mean raw grit scores between the high grade group and the low grade group. The results of the independent samples *t*-tests are reported in Table 4.3. Students in the high grade group had, on average, raw grit scores that were 0.44 points higher than students in the low grade group ($p < 0.0001$), which suggests that those students who are more gritty achieve higher grades, either an honors or a high pass in gross anatomy. There were no differences in the mean raw ITI scores between the high grade group and the low grade group, meaning that students' ITI does not significantly relate to how students performed grade wise.

Table 4.3

Independent Sample *t*-tests

	High Grade		Low Grade		*t*	Mean Difference	95% CI
	M	*SD*	*M*	*SD*			
Raw Grit Score	3.70	0.53	3.26	0.61	**7.46***	0.44	[0.33, 0.56]
Raw ITI Score	3.54	1.07	3.49	0.99	0.43	0.05	[-0.17, 0.27]

Note. Significant *t*-value is indicated in bold.
*$p < 0.0001$

Pearson Product-Moment Correlation

A Pearson chi-square test was used to examine the association between grit and ITI. Results indicated that a significant relationship exists between the grit of individuals and their ITI. Specifically, grit category (high versus low grit) was significantly associated with one's ITI category (Entity or Incremental) X^2 (1, n=382) = 4.05, $p < 0.04$, with an odds ratio of 0.66, 95% CI [0.44, 0.99].

A Pearson product-moment correlation coefficient was used to determine if there was a statistically significant relationship between grit and ITI. Correlations were conducted to determine the strength of a linear association between grit, ITI, and grade percentage in gross anatomy. The correlation coefficient showed a weak, positive, but statistically significant relationship between ITI and grit (r=0.16, p=0.0015). In addition, there was a moderate, positive, statistically significant relationship between grit and grade percentage (r=0.41, $p < 0.0001$). Table 4.4 provides a summary of the correlation coefficients for grit, ITI, and grade percentage in gross anatomy.

Table 4.4

Correlation Matrix for Grit, ITI, and Grade Percentage in Gross Anatomy

	Grit	ITI	Grade Percentage
Grit	-	**0.162***	**0.414****
ITI		-	0.006
Grade Percentage			-

Note. Significant correlations indicated in bold.
*$p < 0.05$, **$p < 0.0001$

Multiple Linear Regression Analysis

Multiple linear regression analysis was conducted to investigate the relationships in two areas: (1) grit and several predictor variables, and (2) ITI and several predictor variables. Specifically, analysis was conducted to address two specific areas: first, to determine the linear relationship between the variable raw grit score while considering the co-variables of raw ITI score, gender, year in medical school, and grade percentage (MODEL 1); and second, to determine the linear relationship between the variable of raw ITI score while considering the co-variables of raw grit score, gender, year in medical school, and grade percentage (MODEL 2).

Several preliminary models were examined to determine which combination of variables produced the best fit model and had the greatest influence in explaining grit or ITI score. Stepwise selection of variables was used in order to find the best regression model, a method where both the forward and backward elimination techniques of model selection are used together (Pagano & Gauvreau, 2000). The variables that produced the best fit model for MODEL 1 included raw ITI score and grade percentage. While the variables that produced the best fit model for MODEL 2 included only raw grit score.

MODEL 1. This model was statistically significant, as indicated by the p-value of the F-test ($p < 0.0001$). The adjusted R^2 value was 0.171 for grade percentage and was calculated to be 0.197 for raw ITI score. These measurements indicate that between 17 - 20% of the variance in raw grit score can be predicted from the variables, grade percentage and raw ITI score. Results of the MODEL 1 can be found in Table 4.5. Results indicated that both the grade percentage ($p < 0.0001$) and raw ITI score ($p = 0.0007$) of medical students were significant variables in predicting one's raw grit score.

MODEL 2. Model 2 was statistically significant, as indicated by the p-value of the F-test ($p = 0.013$). The adjusted R^2 value was 0.023 for raw grit score. This measurement indicates that approximately two percent of the variance in raw ITI score can be predicted from the variable raw grit score. Results from the MODEL 2 can be found in Table 4.5. Results again indicated that the raw grit score ($p = 0.0007$) of medical students was a significant variable in predicting one's raw ITI score.

Table 4.5

Linear Regression Coefficients for MODEL 1 and MODEL 2

	Estimate	*SE*	*t* Value	*df*	*p*	Adjusted R^2
MODEL 1						
Grade Percentage	0.037	0.004	9.09	1	<0.0001	0.171
Raw ITI Score	0.090	0.026	3.42	1	0.0007	0.197
MODEL 2						
Raw Grit Score	0.333	0.097	3.42	1	0.0007	0.023

ANOVA

Analysis of variance (ANOVA) was utilized to determine if there were significant differences in the grade percentages earned in gross anatomy based on the final categorical group a medical student fell within. The final categorical groups were based on the classifications a medical student was assigned to with regards to their ITI (entity or incremental theorist) and their grit (high grit or low grit) status. Thus, the four final categorical groups included: individuals with high grit and an entity theory of intelligence (HE); individuals with high grit and an incremental theory of intelligence (HI); individuals with low grit and an entity theory of intelligence (LE); and individuals with low grit and an incremental theory of intelligence (LI). Table 4.6 provides a description of the four final categorical groups.

Table 4.6

ITI and Grit Status: Final Categorical Groups

Final Categorical Group	*n*	Mean Grade Percentage
High Grit and Entity Theorist (HE)	86	88.30
High Grit and Incremental Theorist (HI)	97	88.28
Low Grit and Entity Theorist (LE)	117	82.47
Low Grit and Incremental Theorist (LI)	82	81.82

Based upon the four final categorical groups, a one-way ANOVA revealed there were significant differences in the grade percentages earned, $F(3, 382) = 31.12$, $p < 0.0001$. Table 4.7 provides a summary of the one-way ANOVA based on final categorical group.

Table 4.7

Summary of One-Way ANOVA Based on Medical Student Final Categorical Groups

		Sum of Squares	*df*	Mean Square	*F*	*p*
Grade Percentage	Between Groups	3554.67	3	1184.89	31.12*	<0.0001
	Within Groups	14391.03	378	38.07		
	Total	17945.70	381	85.12		

The next part of this chapter will present the results of the qualitative analysis of the in-depth, one-on-one interviews that were conducted with medical students, which attempted to help explain the results of the quantitative analysis. The qualitative analysis also goes further to explore the multifaceted experiences medical students had while trying to learn gross anatomy. The qualitative analysis focused on exploring the similarities and the differences between HE, HI, LE, and LI individuals, all in the context of the self-regulatory processes (goal setting, goal operating, and goal monitoring) each individual used while laying their anatomical knowledge foundation.

PART 2: QUALITATIVE RESULTS

This study follows a two-phase, sequential explanatory mixed methods approach. In this approach, the quantitative phase and analysis is followed by a qualitative phase and analysis, where the individuals that participate in the second qualitative phase have also participated in the first quantitative phase (Creswell & Plano-Clark, 2011). This part of the chapter presents the principle themes that emerged from interviews with second, third, and fourth year medical students at Indiana University School of Medicine. Through these interviews, and in the context of knowing their final ITI and grit category, the researcher sought to capture the "richness" of the medical students' self-regulatory processes in learning gross anatomy (Rubin & Rubin, 1995, p. 76). This was done by addressing the following sub-questions:

- Goal Setting: How do medical students set goals in learning anatomy? What are these goals, and why are these goals important to them?
- Goal Operating: How do medical students react to difficult situations while learning gross anatomy?
- Goal Monitoring: How do medical students emotionally evaluate their potential for success as they progress in learning gross anatomy?

The participants in phase two were individuals who were asked at the conclusion of the survey in phase one of the study if they would be interested and willing to participate in an in-depth one-on-one interview to explore how they personally set, acted on, and monitored their goals while learning gross anatomy in medical school. The researcher chose individuals with variable demographics and grade performances in gross anatomy who fell within one of the following four categories: individuals who were entity theorists with a high grit score (HE), individuals who were incremental theorists with a high grit score (HI), individuals who were entity theorists with a low grit score (LE), and individuals who were incremental theorists with a low grit score (LI). This resulted in an interview list of 25 students, with six or seven individuals from each category. A more detailed description of the qualitative strand participants is provided in Table 4.8.

The participants were chosen from those medical students who self-selected to participate on a first response, first invitation, basis. That is, as surveys from phase one were completed and each participant emerged with an assigned ITI category and grit score, those interested in being interviewed were contacted immediately and invited to participate. This continued until the researcher reached the desired number of participants, with variable demographics and grades in each of the aforementioned categories.

Table 4.8

Description of Qualitative Strand Participants

Final Category	*n*	Grade Category[1]	Grade Percentage Range (%)	Gender	Year in Medical School
High Grit and Entity Theorist (HE)	6	High = 4 Low = 2	[75 – 95%]	Females = 3 Males = 3	2nd Year = 3 3rd Year = 2 4th Year = 1
High Grit and Incremental Theorist (HI)	7	High = 4 Low = 3	[80 – 100%]	Females = 2 Males = 5	2nd Year = 6 3rd Year = 0 4th Year = 1
Low Grit and Entity Theorist (LE)	6	High = 2 Low = 4	[75 – 95%]	Females = 1 Males = 5	2nd Year = 4 3rd Year = 1 4th Year = 1
Low Grit and Incremental Theorist (LI)	6	High = 4 Low = 2	[71 – 93%]	Females = 2 Males = 4	2nd Year = 2 3rd Year = 3 4th Year = 1

n=25; [1]High = Honors or High Pass; Low = Pass

Themes in Goal Setting

After repeatedly reading and reviewing the transcripts from participant interviews, principal themes in goal setting emerged from the data and are presented below. Two themes emerged from the data and the themes are used as a framework for organizing findings. The two goal setting themes included:

1. Different Goals for Different Folks.
2. The Internal Conflict between Learning for True Understanding versus the Reality of Grades.

Different Goals for Different Folks

A common topic reported from the interviewed medical students referred to the personal goals individuals set in gross anatomy, and why they set the personal goals that they did. Participants categorized their ultimate learning goal to be one of the following four: (1) to get an honors in the course, (2) to simply pass the course, (3) to understand anatomy and be able to apply it in the future, or (4) to perform at the average in the course when compared to the rest of the class.

Honors was the goal. While grades were clearly important to HE, HI, LE, and LI individuals, there was a unique tendency for entity theorist individuals, regardless of grit level, to place greater importance on final grade outcome in the course. Namely, attaining an honors grade. Interestingly, there were no incremental theorists who reported that an honors grade was their ultimate goal in gross anatomy.

For entity theorists, grades were seen as the primary objective measure to demonstrate, especially to others, that they were learning anatomy. In talking about earning an honors grade as the ultimate goal in gross anatomy, this HE medical student reported the following:

> If I could choose, I would take an honors and know the material less well versus taking a pass and knowing the material really well. I would take the honors because I think career wise, grades tend to have an influence. I did well in undergrad, and it was my grades that got me into medical school. And unfortunately it's how our society is built. I don't remember 90% of the stuff I learned in undergrad…but we live in a society where there needs to be measurements and you need to use those to get your foot into the door. So most of the times an honors is key. (HE6, p. 1)

This quote highlights the fact that medical students are constantly at odds with external forces that influence how they set goals within anatomy. One LE student even made the comment that: "It would be really hard to say no to an honors grade, because you never know where it might come in handy, even if I had to earn it at the expense of really learning" (LE1, p. 3). Though not all entity theorists were of the opinion that they would be willing to sacrifice deep learning at the expense of getting an honors, it was not uncommon for participants to discuss experiences where they had to "hedge their bets" and focus their efforts on the "highest yield" topics of study (LE3, p. 4). And while not all entity medical students actually achieved the honors they strived for, HE medical students did emerge with the highest overall grade average in the course.

In addition to external motivators, internal motivators drove entity theorists in wanting to attain an honors grade. An HE individual commented that:

> I wanted to get an honors in anatomy because I wanted to prove to myself that I could do it. I wanted to prove that I belonged with everybody else in medical school. Because a lot of the material you learn really isn't that important, as far as true understanding for medicine goes, it is a very good scientific base, but as far as being a doctor, it's not super important, but the grade is important as far as more prestigious fellowships and better opportunities in the future. (HE3, p. 2)

Equally, another student reported that:

> I was pretty fixated on getting honors in anatomy. Maybe it was because of the credit hours, or that a lot of people make it seem as though anatomy is this impossible, behemoth course. I felt that if I had the goal of getting an honors, that it would require that I spend my time on it, and I could beat it. (HE2, p. 2)

For those entity theorist medical students who placed getting an honors grade as a central goal for the course, they repeatedly defined success in the context of the grade they received. Success was performing at the highest possible grade level. This became clear when students discussed how their education was designed in such a way that success was intricately tied to good test performances. An HE student illustrated this by commenting that:

> My one true goal was to get 100% on all the exams and everything. I mean we all have that classic must-do-well-to-get-where-going mentality. That concept has been beat into us since we were little. Once we got to medical school, you better get good grades so that you can get the right residency. That's a conversation that is always running in your own head. (HE1, p. 1)

Interestingly, one LE medical student remarked that: "Instead of really trying to learn the material, I knew that in order to succeed, I had to pander to the exam. Pander to the exam at the cost of sacrificing a lot of my better study habits" (LE4, p. 2). It was then with some frustration that other entity theorists discussed how medical school surprised them with how urgent and important achieving a high grade became. One LE individual stated:

> I realized that the only objective measures that I have to show my knowledge are these damn honors, high pass, and pass grades. So I said, you know what? Fine. From now on I will suck up to the grades and I will study to the test to get my honors. Which is interesting to me, because when I came to medical school, I thought learning would be fantastic and it would be a lot of fun, and I wouldn't have to worry about the grades for once in my life. But of course, that is not the case. At the end of the day, you want the grade for a better chance at residency slots. (LE5, p. 2)

It is important to note that other entity medical students were less frustrated in striving for a honors, but saw achieving this goal in anatomy as a personal challenge and method of self-maintenance, a way to "identify the areas where weak spots remained" (LE6, p. 1). One LE student recalled that:

> You jump into anatomy and it's a first semester class and it's very intense at times…so having the goal of getting an honors was a way I could gauge where I was. It challenged me, made me stronger intellectually, and I thought it was an important goal to have. (LE6, p. 2)

This quote highlights, once again, that there were many reasons medical students with an entity theory wanted an honors grade in anatomy. Whether these reasons were extrinsically motivated by factors such as residency placement, intrinsically motivated by factors such as proving one's ability to self, or a mixture of both extrinsic and intrinsic motivations that revolved around a mechanism of self-maintenance in relation to others, depended on the individual. As one LE student put it, "At least with an honors grade on paper, it shows that you knew something at some point really well, and this is an important rule of measurement moving forward in our future" (LE3, p. 5).

I just want to pass. While only entity theorists set their ultimate learning goal as attaining an honors grade in anatomy, other medical students had a different goal. In particular, the ultimate learning goal of some participants was simply to pass gross anatomy. While there were a number of both entity and incremental theorists who had this goal, interestingly all individuals with this goal had low grit.

Low grit did not mean the LE and LI students in this group did not want to learn; they did. However, this group of medical students were of the firm belief that getting an honors in anatomy did not necessarily signify that an individual had learned the information. One LE student concluded that, "I don't think that grades will be the significant indicator whether or not I am competent. I'm okay with a pass grade because I know my stuff and can show that with patients" (LE2, p. 2). This was supported by a LI medical student who commented:

> I think a lot of medical school is structured upon knowing random facts…I don't like that, but they have it, and it's the way they differentiate people. A lot of what we are tested and then graded on is not if you understand the concepts or the stuff that really needs to be known, but do you know that random fact that will separate you from this person and that person? And that is unfortunate, because to some extent that kind of sacrifices the good parts about learning for me, which is learning for my future patients. Not for a grade. (LI2, p. 1)

This quote illustrates the fact that those students who aimed to pass, had their own challenges and frustrations with learning, even when their goal was simply to pass. Even though their focus was not on getting honors, and they did not automatically equate an honors with deep learning, they often felt discouraged about their grades and the grading system they had to operate within. One LI student remembered:

> I felt that I actually knew the material decently well, but my grades didn't support that claim. And the question for me then became, how do you

> know how much you know? Especially since my grades only said I passed, but I felt I really knew my stuff. (LI3, p. 3)

Many of the LI participants in particular described anatomy as “one of the four pillars upon which medical school is based,” a foundation in their education (LI2, p. 2). Anatomy had vital information they recognized they needed: “To understand here and now to get your pass on an exam, but also to really learn it” (LI4, p. 1). Significantly, this group strove for efficiency and balance in their studying, recognizing that it was the “highest yield class” for them that semester (LI5, p. 2). However, it was just as important for this group to: “Keep sane during the first semester of med school and just shoot for passing” (LI5, p. 3).

Yet, reflecting the fact that all students in this category had low grit many, particularly LE medical students, lamented the fact that they could have put more effort into the course, and unfortunately had not. One student with low grit and an entity theory of intelligence described how:

> I lost perspective of the long-term goal…and just focused on knowing what I needed to in order to pass. Electing out of the rat-race everybody else was in as they tried to get honors. But, now I’m feeling I should have had a different goal for myself in that course, because in two years when I’m done, I don’t think I’ll be able to recall some of the more important stuff from anatomy. (LE1, p. 3)

Although many of the LE and LI students in this category did not feel the necessity to strive for an honors in anatomy, not all students felt content in the effort they put forth into their learning. Instead, LE students had more regret about their lack of full effort and looked to other ways their competence might be measured, like extracurricular activities; while LI students typically worked a little harder, with fewer regrets, and saw learning anatomy (irrespective of grade earned) as a necessary foundation for future practice.

To understand anatomy and be able to apply it. Every medical student whose ultimate goal was a desire to understand anatomy and be able to apply it in the future, were highly gritty incremental theorists. Interestingly, no entity theorists, with either high or low grit, identified understanding anatomy and being able to apply it, as their ultimate goal. Additionally, incremental theorists with low grit were also absent from this group. Furthermore, highly gritty incremental theorists were nearly equal with the HE group in terms of overall course performance, with a strong average of 88.28%.

Highly gritty incremental theorists appeared to set goals that had a focus on long term skill and knowledge gain for the betterment of future patients and a clear focus on continuously, almost incessantly, working hard toward constant improvement. This improvement began with a desire to learn the language of anatomy, with one medical student reporting that:

> I was aiming for a fluency with the material, rather than looking for a specific grade. I was looking more to understand and have a conversation with the material and language of the subject. Be able to easily create a roadmap and understand. A fluency of the anatomical language. (HI1, p. 2)

Where a fluency of language was desired, students recognized that they wanted their understanding to go further:

> My ultimate goal, was to learn the language, but I also wanted to become proficient with talking about the human body, be able to speak with physicians about patients. To know where they were talking about and what structures were involved…to understand why anatomy was clinically important. (HI2, p. 2)

Although deep understanding was important to this group, it was equally as important for the HI medical students to have their anatomical knowledge based in the bigger picture of what was important, and not in minute details; minute details that had little clinical application and importance. One student demonstrated this desire, recalling:

> The goal was really to try and focus on understanding well, the functional anatomical parts of the class—the clinical correlates. Because there is so much anatomy, and some of the smaller details are much more obscure and not as important, especially when learning how you apply it to taking care of a patient. (HI7, p. 3)

In addition, HI students often expressed frustration with the amount of detail involved in learning anatomy, failing to see the importance of, or application in patient care, of such detail. One student begged the question, "Why do I need to know everything?" (HI7, p. 4), while still another expressed genuine concern over the struggle to synthesize the details into something more meaningful:

> A lot of times, questions we are asked are just buzz words, detail sort of questions. For example you see the word anemia, you know the answer will be B12, no matter what! Without really learning why or synthesizing. I felt like some courses, not just anatomy, I spent a lot of time synthesizing data, and making meaning of the relationships that you know must be there. (HI6, p. 3)

Finally, HI students continually highlighted how they wanted what they were learning in gross anatomy to "stick" with them long term, into future care of their patients (HI6, p. 3). This was even if it came at the cost of a high grade. One medical student concluded that:

> I think that looking back, grades never really matter that much after the fact. But 10 years down the road…what will matter will be how well I actually know the material. How well did it stick? For if you don't know the material in the clinic its much worse. You need that knowledge to save lives…that's when anatomy becomes really important. (HI3, p. 2)

Performing at class average. Finally, there was a group of low grit, entity and incremental theorists whose ultimate goal in anatomy was to perform at class average. Of note, this group did not contain any individuals with high grit. The performance goal of achieving a grade at, or around, class average for these medical students was in large part so that individuals could put themselves into context of how they were doing with respect to the rest of their class. Having a gauge of their own learning was dependent on others, with one LE medical student recalling:

> I think students need to have some type of degree of understanding where they are in relation to their classmates. For me I always aimed to hover around the average. And that was simply because you have students who came from Harvard and elsewhere, and you don't really know or can gauge how well you are learning unless you compare yourself to them. (LE2, p. 4)

Interestingly, this group of medical students highlighted how they had entered medical school thinking they were "at the very least an average student," and wanted their grades to reflect that (LE1, p. 3). One student felt this was important, because:

> You don't want to get too complacent. Making sure you are at least at the average of the class, lets you know that it wasn't just an easy test. Depending on where the average was, and if you were below it, it doesn't allow you to take that and just sit on it. It was a motivation and a way to keep my pride, I guess. (LE5, p. 3)

Although pride was an important element in the motivation behind the students' choice to focus on the goal they did, it was not the only reason. Medical school for many of the participants, although not limited to this group alone, was an adjustment. However, individuals in this group explicitly articulated the difficulty surrounding this adjustment, with one medical student remarking that "everybody coming to medical school has been high achieving for so long, that it takes some time to adjust to the fact that no longer can everybody be at the top" (LE4, p. 1). Thus, students wanting, and having the personal expectation, to at least be at the class average is not surprising.

The Internal Conflict between Learning for True Understanding versus the Reality of Grades

Although medical students varied in the types of goals they set while learning gross anatomy, there was an overwhelming agreement among all four groups of students (HE, HI, LE, and LI) that at one point or another they had to sacrifice long-term learning for the sake of a particular grade or academic performance. More specifically, all LI, LE, and HE individuals cited having had this happen, with only a very few saying that it had not (these individuals were all HI medical students). One such exception was a HI student that recalled he was “able to learn all of the material well, without having to make big sacrifices” through deciding “to let the smaller details go” (HI2, p. 2). However, even so, it was the exception for a medical student to have not had to sacrifice long-term learning for a particular grade or performance during anatomy, and subsequently throughout medical school.

Consequently, there emerged a deep conflict in most medical students. This conflict revolved around choosing what to sacrifice—one’s grades or one’s understanding—as many felt that it was either one or the other. This conflict was present in most academic endeavors for participants, and seemed to linger at the forefront of participants’ minds, and goal setting reflections. One LE medical student commented:

> I would say a lot of medical school was based on sacrificing long-term learning for the sake of a grade. It’s actually built upon that. Because I would often find myself looking through all this material, and ancillary details like a dose of a drug, or the smallest arterial branch…and that’s something they test on. And unfortunately that takes a spot in my brain, over something that may be something that I really need to know. (LE4, p. 3)

Additionally, participants referenced the consistency of this internal conflict, with one LI medical student recalling:

> I have to battle every single day with the questions, what do I sacrifice? Do I choose to spend the time to really learn this, and not just learn it for a test? Or do I study the tricks and shortcuts that will get me a higher grade or perhaps better residency one day? I think I feel like there is so much information, and to really know it all forever, you would have to fit in countless hours of study, and there is no way you can do that in the time period we are learning all this in. It kind of makes me sad. (LI6, p. 3)

This quote highlights a struggle many participants described, namely, the struggle with feeling there was a choice. A choice between an easier way out (relatively), with tricks, shortcuts, and a stronger guarantee of grade success; versus a choice where you would more comprehensively learn the material, but it would take more time, and carried the risk of not performing as well. One student remembered an experience where limited time forced her to choose the depth at which she was preparing herself for an upcoming exam. Recalling:

> You had to pick. Because of the time you had, you were either going to learn most of the material pretty well, or learn all of the material, but only superficially. Those choices are really hard, and you go back and forth on them. Not really ever knowing exactly what you are giving up. (HE2, p. 4)

Although a struggle, this internal conflict reflects medical students' knowledge and awareness of the changing learning environment. An environment that has become vastly more complicated amid the intellectual demands on knowledge and clinical skills needed for medical practice. Skills that continue to expand to unprecedented, overloaded levels in the field of medicine.

Themes in Goal Setting Summary

Through data collected from interviews, themes emerged which indicated that medical students, depending in large part on their ITI and grit levels, set different goals for themselves while in gross anatomy. Only entity theorists expressed as their ultimate goal the desire to attain an honors grade, finding themselves pandering to succeed on the exam and placing getting an honors grade as a central goal for the course. Success for them was performing at the highest possible grade level. For those participants whose ultimate goal was to simply pass the course, all had low grit. Reflecting this fact, many lamented that they could have put more effort into the course, and unfortunately had not, particularly LE medical students. In turn, all participants whose ultimate goal was to understand and apply their anatomical knowledge were highly gritty and had an incremental view of intelligence. These individuals were focused on long term skill and knowledge gain for the betterment of their future patients. They had a clear focus on working hard toward improving their fluency in anatomy, and synthesizing anatomy with relevant clinical applications. Participants whose ultimate goal was to perform at the course average all had low grit, and often aimed for an average performance in an effort to ensure the preservation of their pride in a highly competitive environment. Finally, participants from all categories voiced their concerns and regrets over having had to sacrifice long-term learning for the sake of getting a particular grade during medical school.

Themes in Goal Operating

Goal operating refers to how an individual reacts to the processes involved in achieving one's goals. After repeatedly reading and reviewing the transcripts from participant interviews, principal themes in goal operating emerged from each group and the data are presented below. Four themes, one for each of the final group categories (HE, HI, LE, and LI) emerged from the data, and the themes are used as a framework for organizing findings. The four goal operating themes included:

1. Do I Belong Here? The Hard Working, Grade-Driven, Self-Questioning Nature of Highly Gritty Entity Theorists
2. Failing Does Not Make a Failure: The Perseverance of Highly Gritty Incremental Theorists Working Hard Toward Deep Understanding and Future Patient Care
3. Am I Smart Enough? The Overwhelmed Nature and Inconsistent Work Ethic of Low Grit Entity Theorists
4. Can I Master the Material? The Struggle of Low Grit Incremental Theorists to Learn in the Here and Now While Wanting To be Competent in the Long-Term

Do I Belong Here? The Hard Working, Grade-Driven, Self-Questioning Nature of Highly Gritty Entity Theorists

All students face challenges when learning. However, the way in which a student reacts to a difficult situation when trying to achieve a goal is often dependent upon personal attributes; two of which are ones' ITI and grit level. Highly gritty entity theorist (HE) medical students are no exception. Data show these participants reacted uniquely to the difficult situations they faced when learning anatomy. They were characterized by three things: (1) they reacted by working harder, (2) they were motivated through grade-driven desire, and (3) they reacted with self-questioning their worth and value. All of these are subsequently discussed.

One of the strongest reactions HE students had while facing a difficult experience or challenge while learning gross anatomy, was to work harder. One student recalled a time when he didn't do as well as he would have liked on a big anatomy exam: "I just used my failure, if you will, to learn how to study better for the test …it just made me work harder, and made me more stubborn to achieve my goal" (HE2, p. 2). When reflecting on how she felt she had overcome challenging times in gross anatomy, another student made it clear: "I just worked harder than I have ever worked before...a ton of work" (HE3, p. 1).

Certain HE medical students faced the challenge of not understanding core tenets of gross anatomy, and once again, reacted by working harder, exhausting their resources and efforts. One medical student recalled:

> The hardest course for me in medical school was gross anatomy, it was just really difficult to make sense of! I remember I was really scared that I wasn't going to pass anatomy right from the beginning…so I knew I either had to do everything I could, literally every single thing I could, or else that's it. (HE5, p. 5)

Now, reflecting the entity side of these individuals, there was repeated talk of intelligence. Particularly, in light of the fact that they felt intelligence was a more fixed entity, working harder was often intricately intertwined with issues of intelligence. One student commented:

> The people that I saw doing well in anatomy were very intelligent people…but I am not a good memorizer of information, it was really stressful. You know, nobody wants to admit that they are having difficulty learning things because you are intimidated by all your classmates. So I said, I know I'm intelligent enough, and I sat down and

> put a little bit more effort into it. And just kept trying and struggling through it, trying to figure it out. (HE4, p. 3)

This quote illustrates how HE medical students reacted by working harder, even when the intelligence of others intimidated one to reach out. Remembering ones' own abilities in terms of innate intelligence enabled many students to keep trying and struggling on. This willingness to continually struggle was expressed by another student:

> I went through a time where I was very distraught and confused, thinking I wasn't intelligent enough, and wondering why I wasn't able to get the material. I should be able to do this! It made me re-evaluate how I learned and if I was using my time wisely. It was a continual process of working hard again and again and again. (HE6, p. 3)

Challenges faced by highly gritty entity theorists were also reacted to with an increased motivation and desire to keep improving their grade—a performance based, grade-driven desire.

> I only got a 90% on the third exam. I had wanted to, and really thought I should have done better than that. So, I thought I should change my habits and work a bit harder because I wanted that honors. And that's what I did; I just faced it with action and more hard work. (HE1, p. 4)

Grades were very important to this group of medical students, and failure simply made them "more stubborn to achieve [their] goals" (HE2, p. 2). Even when it was incredibly difficult to keep focus, and keep working hard, students described reacting to challenges with motivation stemming from the grade they knew was coming:

> In the middle of anatomy when you are struggling it's hard to see the big picture, but I knew that a grade was coming. Well, from then on it was a constant struggle to make sure I was working hard enough, and accept how much time I had to spend with just studying. (HE6, p. 6)

Finally, challenges faced by highly gritty entity theorists were reacted to with an intense reflection and questioning of ones' self-worth and value; a self-questioning that often revolved around doubting if they belonged in medical school, or even deserved to be. Students, more often than not, described how specific challenges made them begin to question themselves:

> I sometimes ask myself, do I belong here? I don't necessarily question my abilities, or have low confidence as far as, can I do it. I just know it's a lot, and I know what I need to do to do it. I work really hard, but sometimes I question whether I belong here when I feel that way. (HE1, p. 2)

Some students remarked how the challenges they faced were "so humbling" and went on to explain that: "It wasn't because I haven't worked hard enough" (HE2, p. 5). Clearly, these students did not feel they were facing challenges or being humbled due to a lack of effort or hard work, yet this didn't keep individuals from questioning their right to be in medical school. A HE student remarked: "When I kept hitting a wall with learning anatomy, it definitely made me wonder if, like, am I supposed to be here, kind of thing. I'm not supposed to be struggling with anatomy!" (HE4, p. 3) In addition, another student recalled that:

> Whenever I faced a failure in medical school, it definitely made me question being in medical school. That's something, that every time I have struggled, that goes through my head—do I deserve to be here? Am I smart enough? I mean, it took me four years to get into medical school, so I was thinking all my family and friends are going to be like there was a reason they didn't accept you all those times! (HE5, p. 3)

It is clear that HE medical students often questioned if they truly deserved to be in medical school, reacting to challenges with a real and acute questioning of their worth and own intellectual abilities. However, this group typically responded with working harder and aiming for a better grade outcome in the course. Struggling that had motivation grounded in a fear of failure and a desire to perform in line with their perceived potential.

Failing Does Not Make a Failure: The Reactive Perseverance of Highly Gritty Incremental Theorists Working Hard Toward Deep Understanding and Future Patient Care

Data showed that medical students who were highly gritty incremental theorists reacted distinctively to the challenges they faced when learning anatomy. Strikingly, two things characterized this group: (1) they reacted with a perseverance deeply rooted in hard work, and a desire for true understanding with an eye on their future patients; and (2), this group reacted with incredible resilience even in the face of failure. Failure did not shake their resolve, and even more importantly, failure did not make them feel like they had failed, but rather it was seen as an opportunity from which to learn and become better.

Reacting with perseverance is a mastery-oriented response, a response focused on the long-term rather than working for short-term academic gain or reward. When facing a challenge HI medical students described how they rooted their reaction in working harder and keeping an eye on the long-term goal, which for many was competent patient care. As one medical student stated:

> I remember a difficult area to learn for me was the pelvis. I would say to myself, that if I can understand this material enough to where I feel comfortable using it, especially when I am working with other doctors around patients, then I know I know the material. Really that's what matters, knowing you know it when you will one day have to treat the patient by yourself. (HI1, p. 3)

This quote illustrates that while HI medical students faced challenges in learning anatomy, their reaction to these difficulties often resulted in looking past the immediate struggle and allowed them to recognize why it was they were putting in the work that they were. Oftentimes, this perspective then allowed the struggle itself to be embraced with a positive outlook:

> I think that I saw learning the difficult 3-D parts of anatomy as a challenge, and I never once suspected that I wouldn't be able to overcome it. So, I just said I should focus on what's working. And keep working at it. Eventually it just clicked, and there were many of those moments where on the third, fourth, or fifth pass it all came together, it just clicked. And I knew I wouldn't forget it. (HI2, p. 4)

Although a positive outlook was conducive in helping students push through a challenge, for HI students, it often came back to hard work. Not giving up, and persevering through, or as one student put it: "It just matters how much hard work you put in" (HI4, p. 3). One medical student described his first line of defense when facing a challenging situation:

> Primarily, what I do first is make sure that I am sitting down and actually understanding it…I am not one to give up easily. I really find as many avenues as possible, if it's a video online, speaking to a TA, or whatever. I don't give up. I put in the effort and the time to actually find the answer. I just don't let things go. (HI3, p. 2)

It was clear that perseverance was key to these students' reactions to challenges. Even when a particularly difficult situation made them question their own abilities, they were able to reason through, and keep their goal focused on the long-term:

> Sometimes I would think, can I ever get this? The thing with med school is, is you can't compare yourself to other people. You have to do what you do, and stick to that. So if I'm struggling with a concept and another guy isn't, I'm not going to think I'm stupid. I know I will stick with it until I learn what's important for being a doctor. (HI5, p. 3)

Finally, HI participants expressed a sense of comfort in working hard and moving past simple memorization:

> I am more comfortable knowing the material…when you read something and a word comes up, it triggers knowledge, and you can talk about it, and you understand it. It makes me feel a lot more comfortable to really know

> something, and discuss something in depth, than to just memorize something momentarily. (HI6, p. 2)

Another characteristic of the HI medical student was reacting to challenges with resilience, even in the face of failure or negative feedback. Failure typically did not shake the resolve of this student group, and was seen as an opportunity from which to learn and improve. Importantly, failing at something did not make one a failure, or as one participant said:

> Not doing as well as I would like, doesn't make me a failure or a lost cause. I knew I could do better. I just moved on from it, using what I learned, and knowing I would do better next time. (HI3, p. 3)

From this quote it is clear that students were willing to learn from their failures. In addition, while not always wanted, negative feedback was generally internalized and given consideration. One medical student commented that:

> If I got negative feedback, I would try to see the other person's point of view. I am very open minded about it and will do my best to change what needs to be different. I realized it could be a way for me to improve. (HI2, p. 4)

Furthermore, when recalling a specific example of receiving negative feedback, a medical student said:

> I remember after our first anatomy quiz I didn't do that well, but my roommate had. And as we walked to the car together afterwards, his immediate response was, well I don't think you were studying very effectively. I took it as kind of an insult…but I calmed down after he explained why, and I felt the feedback was actually helpful. It made me change my approach for studying, and I did a lot better the next quiz! (HI5, p. 4)

Ultimately, many HI medical students saw failure and negative feedback as "something that went a bit wrong," but an opportunity to "try to do better, and make the best of a learning situation," using the situation to challenge oneself to "be the best doctor you know you can be" (HI6, p. 3).

Am I Smart Enough? The Overwhelmed Nature and Inconsistent Work Ethic of Low Grit Entity Theorists

Medical students who were low grit entity theorists (LE) uniquely reacted to the difficult situations they faced when learning anatomy. Two things characterized their reactions to challenges: (1) they became very overwhelmed, questioning if they were smart enough, and (2) they displayed an inconsistent work ethic. These areas are subsequently discussed.

One of the strongest reactions LE students had when facing a challenging experience in gross anatomy was to become overwhelmed; an emotion that eventually led them to question their intelligence and if they were smart enough to complete the task at hand. A medical student evidenced this with saying: "It's hard not being at the top of the class anymore, it made me question my intellectual abilities…you ask, does this mean I'm not smart enough?" (LE3, p. 4) Another student remembered when they had struggled on a few exams:

> I always knew I could do med school, but it is really stressful to know that you're not doing it well. You begin to ask yourself, am I smart enough to do this? You're surrounded by so many people who are so smart…it is tough to see so many people doing so well. You begin to think you're not cut from the same cloth. You begin to think that these people are just really gifted, and maybe I will always be toward the lower half of the class. (LE1, p. 5)

Being overwhelmed led to frustrations and these frustrations would sometimes extend into the classroom. One student described being so frustrated that: "I kind of almost didn’t want to study the material because I was mad at this professor and the way that he taught, which is so juvenile, but I couldn’t help it” (LE2, p. 3).

In addition to feeling frustrated after failing an exam, one medical student concluded that: “I knew I had a talent deficiency in gross anatomy, which meant I had to work that much more hard than others, for a lot less reward” (LE4, p. 3). The overwhelming nature of such a conclusion made students feel very insecure about their knowledge, “question their ability to do better” (LE5, p. 4), and worry what people might think about their ability to practice medicine. Especially as one student put it:

> I think everybody coming into med school, well nobody is used to being in the bottom, and when you see it, it is shocking and frustrating….nobody comes into school thinking that a pass will be good enough, but you soon realize that you have to accept that, and you change your goals. (LE6, p. 3)

Finally, LE medical students showed an inconsistency in their work ethic. After experiencing a setback, one medical student recalled that: “I think it affected my goals, like maybe med school wasn’t that important anymore…maybe I was putting too much focus on school. So I thought maybe I will just pass this” (LE3, p. 3). In addition, another medical student expressed concern with their ability to be consistent in their efforts:

> I really struggled with exams, and I started to get the mentality that I couldn’t perform on those exams, and I got really inconsistent in my efforts as medical school has gone on. Maybe I’ve just gotten more and more worn out, burnt out. So this initial great spark that I had, to really do something about my grade and learning, has dwindled over time. (LE4, p. 3)

The loss of this learning spark as the previous quote illustrates was a realization that multiple students came to over time. Recognizing how certain challenging events in gross anatomy broke their spirit:

> The first exam was a humbling, or a breaking sort of experience. Breaking in the sense of taming a colt, a horse. And realizing that you go from being the best of the best, to now just being another face in a crowd…it's really hard and kind of sad. (LE5, p. 3)

Overall, LE medical students really struggled through challenges, often becoming overwhelmed, questioning if they were smart enough, and throughout it all, had an inconsistent work ethic. It was clear that struggling and setback really affected these students, in particular, affected their work drive; a work drive that diminished or was lost in conjunction with the loss of the students' learning spark.

Can I Master the Material? The Struggle of Low Grit Incremental Theorists to Learn in the Here and Now While Wanting to be Competent in the Long-Term

Medical students who were low grit incremental theorists were distinctively characterized by their reactions to challenges in two ways: (1) they struggled in their ability to master the material in the present, in part due to a lack of hard work and persistence; yet (2) they still expressed a desire to learn the material for the long-term, meaning their focus was on becoming competent practicing physicians in the future.

The LI medical students' stories about trying to understand complex anatomical relationships in the body were numerous; students often felt a sense of discouragement when things "were hard to wrap [their] head around" (LI2, p. 2). Discussing how, "I would throw up my hands at it and just forget about it. I was just going to miss that on the test, so I would plan to take the hit" (LI1, p. 2). It was clear that certain students struggled with the material and internalized this struggle:

> I began to question my ability to really learn anatomy so I could use it as a doc someday. It's just when everybody else picks it up, and you don't, it's very easy to say, they're smarter than me. Maybe I shouldn't have gotten into med school. That definitely goes through your mind and keeps you from wanting to put more time into it. (LI2, p. 4)

These quotes illustrate how LI students often first struggled with the material, second, questioned their ability to master the material, and finally, would in part or wholly, give up on the necessary hard work it took to learn anatomy.

The struggle to master the material for the LI student was often accompanied by fear. One student commented that, "I was scared a lot of the time. I was internally stressed and constantly fearful that I could fail" (LI3, p. 4). With another describing trying to learn anatomy as their "Achilles heel," I "was so scared I felt utterly helpless and realized that I wasn't going to master it" (LI4, p. 2).

Realizing they were no longer the "brightest student in the class anymore" was a scary and humbling experience for many LI students (LI6, p. 2). However, many still expressed the desire to learn the material for the long-term, in order to be "well prepared to be a good future doctor" (LI3, p. 4). Oftentimes LI students discovered that one had to:

> Prioritize your learning. You had to focus on getting…the big ideas down well. Then the other thing you have to accept is that there will always be something you don't know. You realize you need to retain as much as you can for your future patients, because you will never understand or know everything. It's about focusing on the big stuff. (LI6, p. 6)

Although LI students expressed an interest in being competent physicians for the good of their future patients, it was clearly a struggle for them to learn anatomy in the present. A struggle with challenging concepts, which subsequently led many to get very discouraged, give up, or lose the desire to put in the extra work necessary for true understanding.

Themes in Goal Operating Summary

Largely dependent upon a medical students' ITI and grit level, prominent themes emerged from the data collected via interviews. These themes indicated that HE, HI, LE, and LI medical students react quite differently to the processes involved in achieving one's goals in gross anatomy. While HE medical students often questioned if they truly deserved to be in medical school and doubted their own intellectual abilities, this group typically responded with working harder and aiming for a better grade outcome in the course. On the other hand, HI medical students saw failure and negative feedback as an opportunity from which to learn; feedback that didn't lead to questioning of self-worth, but rather allowed students to become better physicians for future patients. LE students really struggled through challenges. Due to an inconsistent work ethic, these students often became overwhelmed and questioned if they were smart enough to practice medicine. Finally, like LE students, LI students also struggled with mastering the material and maintaining consistent effort, yet when compared to LE students they expressed a stronger desire to learn concepts well for their future patients.

Themes in Goal Monitoring

When it comes to monitoring goals, both entity and incremental theorists tend to attribute their performance and progress toward a goal to different factors. Yet, both types of theorists view ability and effort as important determinants. However, in general, entity theorists tend to attribute performance to personal ability, while incremental theorists and grittier individuals attribute performance to personal effort. In addition, the emotions that accompany each type of theorist range from the negative: feelings of vulnerability and anxiousness; to the positive: feelings of optimism and confidence.

After repeatedly reading and reviewing the transcripts from participant interviews, principal themes in goal monitoring for medical students emerged from the data and are presented below. Specific focus was placed on understanding themes related to the emotions medical students felt as they progressed through their gross anatomy experience. The following two themes are used as a framework for organizing findings. The two goal monitoring themes included:

1. The Emotional Power of an Individual's ITI
2. Grit Level Moderates the Coping Response to Negative Emotion

The Emotional Power of an Individual's ITI

Although nearly all medical students reported feeling negative emotions at some point during the semester in gross anatomy, entity theorists overwhelmingly reported feeling vulnerable and anxious as they monitored their progress in the course. Interestingly, grit level did not appear to keep one from feeling these emotions, as both high and low grit entity theorists reported feeling vulnerable and anxious. One medical student near the beginning of the course talked about how she felt anxiety: "Yeah, I felt pretty anxious…had many moments where you sit there thinking how in the world am I supposed to know and learn this!" (HE4, p. 5) Another student described the negative emotions surrounding the confusion that overwhelmed him while learning anatomy:

> Anxiety was pretty much my unwelcomed best friend during medical school. It was the volume of material you are expected to get through that was a lot, and you realize that you are not going to get through it, and then you begin to feel really anxious. Then instead you're using your time to worry. (HE5, p. 4)

In addition to the concerns entity theorists had regarding spending time worrying instead of studying, students expressed unease about the sheer amount of anxiousness they felt:

> I was pretty high strung throughout anatomy. It's a lot to take in, and it's quite the adjustment from undergraduate. I felt kind of vulnerable. And that was not a good thing for me…vulnerable because I felt overwhelmed by everything. Like, am I learning things fast enough? Am I learning this well enough? A whole semester of that really makes an already tough class, that much tougher. (LE3, p. 9)

The fact that a difficult course only became more difficult with excessive worry and anxiousness, illustrated the complexity of managing negative emotions while struggling to learn. Some students commented on the fact that anxious worry accompanied the way in which they decided how to study: "I was always worried that I wasn't studying the right thing in the right way and that was going to impact things. Impact my chances at passing the course" (LE7, p. 3).

Conversely, incremental theorists had fewer negative emotions that accompanied the monitoring of their personal progress in gross anatomy:

> I was fairly confident and optimistic as I went through gross anatomy. I was most optimistic about knowing that the information would help me in my future. I saw clear application for all the information. It was an important part about learning this stuff; if I can see using it in the future I usually feel confident in my approach to learning it. (HI3, p. 4)

Confidence clearly percolated into incremental theorists' views concerning how anatomy provided a platform upon which they improved their communication skills:

> Being a good and successful doctor is more than just what the numbers on a page say. When you actually get into the field, it's a lot more about communication and how you work on a team. How you can relate to a patient…I think anatomy lab helped to teach us how to communicate about what was really our first patient. (LI4, p. 5)

Feeling confident “beyond the numbers on a page” (LI4, p. 5) was echoed by another medical student who commented that: “Even if my grades aren’t honors, straight honors across the board, I am still confident and comfortable where I am at. There are other metrics to measure success by, like how you interact with patients.” (LI5, p. 4)

Grit Level Moderates the Coping Response to Negative Emotion

Even though one’s grit level did not keep an individual from feeling negative emotions as they monitored their progress throughout gross anatomy, grit level was key in determining the coping mechanisms an individual would exhibit in response. When compared to low grit individuals, high grit individuals exhibited more effective coping mechanisms to the anxiety and vulnerability they felt. Coping mechanisms revolved around working harder, re-doubling efforts, and re-evaluating study methods in order to restore any lack of confidence that negative emotion may have elicited. One student remembered that:

> Yeah, I would sometimes feel anxious. Anxiety and stress…but that would only make me study more. Work harder. My thing was that I get the most anxiety when I feel behind, or I don’t feel adequately prepared. If I feel that I have done everything in my power to prep, then I know I’ve worked hard enough. (HE3, p. 5)

Some students commented that while anxiety was present when struggling to understand complex subject matter, their plan of action involved going beyond their normal study habits: “Sometimes you have to develop new study habits that you haven’t tried before, which can be scary to branch out…but it’s either that or the course begins to downhill spiral out of control” (HI6, p. 5).

Another medical student went on to explain that even though he definitely had moments where he felt vulnerable and anxious, he was comfortable feeling this way, for as he put it:

> I think it's healthy and I think it's the right way to go about learning in a course. You have to allow yourself to feel a bit vulnerable and anxious, and confused! Being confused is a really really important part of learning, and figuring out what's wrong and then how to devise a plan to make things right by working smarter…that's the best. (HE4, p. 6)

However, not all students were so positive and comfortable feeling vulnerable and anxious. In particular, low grit individuals often felt paralyzed in their emotion, with some even recalling how it made them lose their joy in the learning process:

> Sometimes I would just panic and wouldn't know what to do…even felt nauseous a few times. But the fear you have when you think about having to do well follows you everywhere. It unfortunately takes a lot of the joy I have in learning new things out of medical school. It's just a lot of worry. (LE4, p. 5)

Whether it was losing the joy that once filled the learning process, or a developing sense of apathy because there wasn't enough time to fully process the vulnerability one felt, depended on the individual. One medical student commented that:

> I was not expecting to have to do so much learning on my own…and that made me anxious. But really my anxiousness turned into apathy, because I didn't have the energy to figure stuff out, and I just became resolved that what's going to happen will just happen. (LI1, p. 5)

Themes in Goal Monitoring Summary

Specific attention was directed to understand the emotions medical students felt as they progressed through their gross anatomy experience. As such, there were two major goal monitoring themes that emerged from examination of interview data. First, an individual's ITI, more so than grit level, appeared to drive the presence or absence of negative emotions in a medical student. Those with an entity ITI overwhelmingly reported feeling vulnerable and anxious as they monitored their progress in the course, while those with an incremental ITI had much fewer negative emotions that accompanied the monitoring of their personal progress in gross anatomy. The second theme revolved around grit; namely, it emerged that grit level was key in moderating how a medical student would respond to the negative emotions they felt. Specifically, when compared to low grit individuals, high grit individuals exhibited more effective coping mechanisms to the anxiety and vulnerability they felt. These individuals responded by working harder, developed new study habits, and allowed themselves to have confusion and worked through it.

Chapter Summary

This chapter elucidated findings from quantitative survey data and qualitative interviews with second, third, and fourth year medical students at Indiana University School of Medicine. Multiple themes emerged with respect to one's ITI, grit level, and the goal setting, goal operating, and goal monitoring processes of medical students in gross anatomy. The next chapter further elaborates on these themes through an in-depth discussion of this research.

CHAPTER 5: DISCUSSION AND CONCLUSIONS

Overview

This study explored the relationships between medical students' beliefs about intelligence and grittiness in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy. The study employed a two-phase, sequential explanatory mixed methods case study approach that used an initial quantitative phase of data collection and analysis, followed by a qualitative data collection and analysis.

In phase one, quantitative data collection consisted of having medical students, who had successfully completed their gross anatomy requirement, complete the Implicit Theory of Intelligence Scale (ITIS) survey and the Short Grit Scale survey in order to identify the structure of their implicit theory of intelligence and grit score, respectively. The ITIS survey was developed by Carol Dweck (2000) and identified and assessed the degree to which participants considered intelligence fixed or malleable. Conversely, the Short Grit Scale was first modeled by Duckworth and colleagues (2007) and quantitatively measured the perseverance and passion, or grittiness, that an individual has for long-term goals.

The quantitative research questions during this phase addressed three areas: (1) the ITI that medical students held; (2) medical students' level of grit; and (3) the relationships between medical students' ITI and grit while considering the variables of gender, year in medical school, and grade performance in gross anatomy. In addition, this phase identified participants who were asked to participate in phase two of the study. The quantitative analysis resulted in three main conclusions: first, entity and incremental theorists with high grit performed significantly better in gross anatomy when compared to those with low grit; second, a moderate positive association existed between grit score and grade performance; and third, a weak, positive association existed between ITI and grit, indicating a relationship between those with higher ITI scores (representing a more incremental theory of intelligence) and those with more grit. These findings support research conducted at other institutions and academic levels; namely, findings that concern the examination of grit as a predictor of educational achievement and satisfaction (Bowman, Hill, Denson, & Bronkema, 2015). Specifically, these studies showed that at the undergraduate level higher levels of grit were predictive of greater academic achievement, college grade point average, college satisfaction, and intent to persist at a task (Bowman et al., 2015).

In phase two of the study, 25 semi-structured, in-depth, one-on-one qualitative interviews were conducted to explore how medical students set goals, operated while reaching those goals, and monitored their progress in achieving those goals while learning gross anatomy. Specifically, the following research question outlined and guided this phase of the study: What are the relationships between medical students' beliefs about intelligence and grittiness in relation to their self-regulatory processes of goal setting, goal operating, and goal monitoring in learning gross anatomy? This was asked in order to explore the ITI held by medical students, their grittiness, and how individual self-regulatory processes in gross anatomy were influenced by the characteristics of ITI and grit.

The qualitative analysis revealed several key differences that explained the variances seen in performance and went further to illuminate how those with different levels of grit and dissimilar implicit theories of intelligence approached, reacted to, and executed learning processes so very differently. Qualitative data showed highly gritty individuals (both entity and incremental theorists) were hard workers and showed resilience in the face of challenges. Furthermore, highly gritty individuals with an incremental ITI strongly desired to understand anatomy in order to apply it to future patient care. Conversely, those with low grit typically became overwhelmed by intellectual challenges, were more likely to show an inconsistent work ethic, and often questioned their ability to master the material. In addition, an individual's ITI, more so than grit level, appeared to drive the presence or absence of negative emotions in response to a challenge. Specifically, those with an entity ITI overwhelmingly reported feeling vulnerable and anxious as they monitored their progress in the course, while those with an incremental ITI reported much fewer negative emotions. It emerged that grit level was key in moderating how a medical student would respond to the negative emotions they felt, with high grit individuals exhibiting more effective coping mechanisms to the anxiety and vulnerability they felt, i.e., responding with hard work, developing new study habits, and allowing one's self to have confusion and work through it. Finally, all participants, regardless of their ITI or grit level, expressed that at one point or another they had to sacrifice long-term learning for the sake of a grade.

Revisiting the Concepts of ITI and Grit

In the field of medicine, research has begun to point toward the importance of understanding how non-academic factors drive learning (Naylor et al., 2008; Burkhart et al., 2014). ITI and grit are two of these important non-academic factors and have been at the center of this study. In terms of grit, the literature has shown it to be a superior predictor of success in a number of high achievement and high stress fields, such as the military, academia, law, and medicine (Duckworth et al., 2007). In fact, grittier individuals are less likely to drop out of their respective life commitments and are more likely to complete the tasks they begin. Grit has been used to predict retention “over and beyond the established context-specific predictors of retention (e.g. intelligence, physical aptitude, Big Five personality traits, job tenure)” (Eskreis-Winkler, Duckworth, Shulman, & Beal, 2014, p. 2). Grit has also been shown to be associated with lifetime educational attainment, academic performance at elite universities, and success in National Spelling Bees (Duckworth et al., 2007; Duckworth, Kirby, Tsukayama, Berstein, & Ericsson, 2011). Finally, in multiple studies, grit has “accounted for significant incremental variance in success outcomes over and beyond that explained by IQ” (Duckworth et al., 2007, p. 1098). Many of this study’s findings support the aforementioned research, and actually goes further to elaborate on the unique medical student population.

In addition, current literature in social cognitive research suggests that understanding the implicit theories of intelligence of an individual is important, due to the fact that relatively often, these beliefs determine an individual’s attitude and behavior and have the ability to predict achievement across a particular event (Blackwell et al., 2007; Garcia-Cepero & McCoach, 2009). Dweck and Molden (2005) cited that there are profound educational consequences for individuals depending on the type of theory they believe in, as these beliefs will predict the type of learning goals an individual sets. Furthermore, with respect to entity versus incremental theories of intelligence, Dweck (2000) said that they “seem to create entirely different frameworks for students…once students adopt a theory of intelligence, it affects what they value, how they approach intellectual tasks, and how they respond to what happens to them" (p. 16). Again, many findings in this study, subsequently discussed, support these ideas.

The quantitative and qualitative findings from this study inform the conclusions and discussion. Even though data were collected and analyzed separately, each phase informed and supported the other. The remaining portion of this chapter blends the two types of data to provide a holistic presentation of the data on ITI, grit, and the self-regulatory processes of medical students, through revisiting major themes and offering implications for practice and future research.

Revisiting the Themes

Themes in Goal Setting

In previous research, goals have been defined as the internal representations of desired states (Austin & Vancouver, 1996). These desired states are often incredibly persuasive motivating forces in one's behavior, with goals often being the object or aim of an action—and medical students are no exception to this (Locke, Shaw, Saari, & Latham, 1981). Although goal setting in anatomy has received relatively little attention in the medical literature, research in the social sciences suggest that the articulation of goals may be fundamental in carrying out effective learning strategies (Bradley, Bogardus, Tinetti, & Inouye, 1999). Goal setting may enhance both the process and outcome of learning gross anatomy in several ways. First, goals may help students link information learned in the classroom to future patient care. Second, goals may help students explicitly link learning objectives in gross anatomy to the material they are learning in the present. And finally, goals can provide the motivation to sustain effort over the long-term, and throughout learning challenges.

Many medical schools include in the goals for their students, a desire for their graduates to leave with the ability to self-assess and self-regulate their education throughout their professional lives—in essence, to be able to set, and act upon, lifelong learning goals (White, 2006). Although most previous goal-setting research has been in the fields of psychology and organizational behavior, this study, in part, has examined the goal setting processes of medical students in the context of gross anatomy. As Bandura and Locke state, “humans are motivated by foresight relative to where they want to be,” and this includes medical students (Oettingen & Hagenah, 2005, p. 652). Findings in this study have shown that goal setting has an effect on individual medical student behavior and learning outcomes. Interestingly, the investigator found that medical student participants fell into one of four categories when asked to describe the ultimate personal goal they set for themselves while in gross anatomy. Their goals were either to: (1) get an honors in the course, (2) simply pass the course, (3) understand anatomy and be able to apply it in the future, or (4) perform at the average in the course when compared to the rest of the class.

Results from this study indicated that one’s ITI and grit level largely determined which aforementioned goal category an individual fell into, resulting in student groups with very different learning goals. Dweck and Molden (2005) cited that there are profound educational consequences for individuals depending on the type of theory they believe in, and that, depending on whether one views intelligence as fixed or malleable, will predict the type of learning goals an individual sets. For example, students who hold an entity theory of intelligence are likely to endorse and set performance goals, while those who hold an incremental theory of intelligence are likely to endorse and set mastery-oriented goals. The findings in this study suggest that this holds true, even for medical students; specifically showing that only entity theorists reported that getting an honors was their ultimate goal.

Entity theorists, with the goal of honoring in the course, expressed that they would even be willing to sacrifice essential knowledge for the sake of an honors grade, citing reasons such as the pressures to place in future residency spots, a need to prove one's own intelligence to self, and having concrete proof that at "one time [they] did know something about anatomy" (HE2, p. 5). Not surprisingly, participants' views about sacrificing knowledge for the sake of a grade echo in the literature as well. For example, White (2006) suggests that students whose focus is on grades often end up being "passive recipients of knowledge—they do a lot of memorizing and applying basic principles to problems defined by faculty—and their role as learners is mostly passive/dependent" (p. 293). Although IUSM strives to develop students' skills and knowledge to better prepare them for practice, the reality of individual student goals and motivations must be considered. For only by knowing these will educators be able to strategize to design a classroom in which dialogue and debate require learners to learn for learning's sake, and not for a grade on a test.

When considering the goals that students with high grit set for themselves, additional trends emerged. Namely, highly gritty students either wanted to get an honors in gross anatomy or desired to understand anatomy and apply it in the future. It is not surprising then that quantitative results of this study revealed that entity and incremental theorists with high grit performed significantly better in gross anatomy when compared to those with low grit. As the literature suggests, grittier individuals are more able and likely to maintain a sustained and focused effort throughout an extended period of time "despite failure, adversity, and plateaus in progress" (Duckworth et al., 2007, p. 1088). The findings of this study support this literature and the qualitative data only enhanced the quantitative findings. Data showed that those with high grit exhibited an incredible endurance to work hard, adjusted deficient study approaches if needed, showed deep resilience in the face of challenges, and consistently aimed toward reaching their goal.

It is critical to note, that according to Teunissen and Bok (2013):

> In medicine, holding either a performance or learning goal orientation exclusively can be problematic given the tasks in this field of endeavor are dynamic and complex, professionals are required to perform well for the good of their patient and at the same time to learn new skills on a continuous basis, and [student] doctors must be able to transfer skills to new tasks. (p. 1066)

This is an important point to consider because medicine, and learning anatomy within the field of medicine, is unique. Having students exclusively focus on either getting an honors grade (a performance goal, often associated with entity theorists), or learning anatomy for understanding and application (a mastery-oriented learning goal, often associated with incremental theorists) may not be the most effective or desirable orientation. It may be that those students with a mix of both performance and learning goals, like Teunissen and Bok (2013) suggest, in combination with a high level of grit (as this study indicates is advantageous), is the best formula for student success in anatomy. More research is needed to confirm this.

It is clear, however, that although medical students were varied in the types of goals they set while learning gross anatomy, there was an overwhelming agreement among all four groups of students (HE, HI, LE, and LI) that at one point or another they had to sacrifice long-term learning for the sake of a particular grade or academic performance. With this acknowledgement emerged a deep conflict in most medical students. This conflict revolved around choosing what to sacrifice—one's grades or one's understanding—as many felt that it was either one or the other. This conflict is not unique to the students attending IUSM; students surveyed from Dartmouth, the University of Florida, and the University of New Mexico were asked about their medical school experience and asked the question: How much did you learn by memorizing without understanding (Small, Stevens, & Duerson, 1993)? While percentages varied, in the first two years of medical school students cited on average that over 45% of their learning was done via memorization without understanding (Small et al., 1993).

We must ask ourselves, are we okay with our medical students feeling they have to make this choice, intentionally memorizing without understanding? Although results from this study show that students often have feelings of regret, internal conflict, and disappointment when they feel they put gaining long-lasting knowledge secondary to a grade, some research concerning the depth-versus-breadth debate in medicine would suggest that this trade-off is not necessarily a bad thing.

At first glance one could understand, maybe even agree with the medical students, that sacrificing any depth of learning for breath of learning might be unfavorable—leaving medical students with detrimental gaps in their knowledge. However, Hung, Bailey, and Jonassen (2004) argue that it is not possible, and not even desirable, for medical students to learn or cover everything in medical school. Since "knowledge is constantly expanding…we question the possibility that any course, or program of studies, can provide a full understanding of a content's breadth or depth" (Hung et al., 2004, p. 14). This suggests that perhaps the internal conflict seen in the medical students who participated in this study is not as discouraging as originally thought. Furthermore, it is important to keep in mind that up to this point in their education, medical students have likely appreciated, but not fully understood, the depth and breadth that a course in medical school requires. Students, may for the first time, be feeling the weight of responsibility of really knowing and sensing an accountability for an entire body of information. The foreignness of this emotion thus may require time spent feeling this conflict of choosing between a grade and understanding, before some sort of reconciliation with their new reality of what they will face as they traverse medical school, residency, and recertification processes as physicians, is embraced.

Consequently, as educators we have the opportunity and responsibility to explicitly address and acknowledge this learning conflict in our students, countering with reassurances that we do not expect them to learn everything. Even though evaluation and factual overload drives the current system, students need choices about, and control over, aspects of their own learning (Small et al., 1993; Hagen & Weinstein, 1995). When learners are solely reliant upon others for their learning, they look for cues about how and what to learn—focusing on figuring out what the teacher wants from them, and on what they will be assessed (White, 2006). This game of figuring out what the teacher wants, was echoed in the qualitative findings of this study, particularly in students' commentary concerning how they felt they had to sacrifice real knowledge and understanding to "pander to the exam," as they knew what it was the teacher was looking for (LE4, p. 2).

Unless all students in a medical school classroom are HI students, which data indicate they clearly are not, goals of the educator versus goals of the student will likely encompass different ideals that do not fully align. These conflicting goals—between the student and the educator—may result in substantial disagreements in how one approaches learning or navigates a course with misaligned perceptions concerning why challenges arise. If the gross anatomy educator desires for students to embrace the goal of learning anatomy to truly understand it, not only for immediate use, but future application, then a curricular focus that takes students' ITI and grit into consideration, is necessary. A curriculum designed which focuses on and rewards learning, based on deeper understanding, not superficial, has the potential to create a system that rewards grit and allows students to avoid choosing between a grade and understanding (Bransford, 2000; Sibley & Parmelee, 2006). What this curriculum would look like is still an unknown, since curricula have not yet been designed with consideration of student grit or ITI.

Themes in Goal Operating

Goal operating refers to how an individual reacts to the processes involved in achieving one's goals. ITI and grit directly and indirectly (i.e., by encouraging certain goals) "set up students' reactions to difficulty, which [go] on to predict the course of their self-esteem and achievement"; more specifically, "ITI and goals together set up a framework in which people interpret and respond to setbacks" (Dweck & Grant, 2008, p. 408). Because some students in this study had performance oriented goals (getting an honors grade, performing at the average of the class, or just passing), and others had learning oriented goals (learning anatomy to understand and be able to apply it), it is interesting to see how these goals impacted participants' reactions to the setbacks and challenges all medical students reported experiencing.

With regard to the negative feedback, failures, adversity, stress, and plateaus in progress that medical students faced while learning gross anatomy, qualitative findings in this study provide some insight. Data show that grittier individuals exhibited more effective coping mechanisms to negative feedback, anxiety, and the vulnerability they felt during learning. High grit participants responded to challenges and setbacks with additional hard work, developing new study habits if needed, and permission to allow one's self the mental room to struggle intellectually and continue working through it. Conversely, low grit individuals were characterized by a more inconsistent work ethic, became easily overwhelmed by challenges, and frequently questioned their ability to complete the task at hand.

The limited research that has been conducted on grit in the medical field echoes these findings, and indicates that ineffective coping mechanisms can have lasting effects on a learner. Researchers found that grit was predictive of later psychological well-being of medical residents in nine surgical specialites, and that grit can be used to identify those residents who are at greatest risk for poor psychological well-being in the future (Salles et al., 2014). Researchers even went so far as to suggest that grit levels could be used to identify residents who would benefit from counseling or additional support in the present in order to improve their coping skills in the future (Salles et al., 2014). Along this line, newly emerging research in undergraduate medical education indicates that medical students who rely on their grit show greater adaptation and persistence to overcome learning barriers (Balmer, Richards, & Varpio, 2015). Hence, the prospect of measuring the grit of our medical students becomes even more appealing for as it is more fully understood it could be used to identify those students in greater need of support and assistance during anatomy, and subsequent coursework, to improve their coping mechanisms, and proactively attend to their psychological well-being.

In addition to the aforementioned findings concerning grit and reactions to challenges, a Pearson product-moment correlation coefficient test found that there was a moderate, positive, statistically significant relationship between grit and grade percentage. However, this is only part of the picture. It comes as no surprise that the literature suggests that grade performance is only one indicator of academic success and competence; and found evidence to indicate that "the pivotal issue in achieving competence is how people respond to negative feedback" (Oettingen & Hagenah, 2005, p. 657).

There is no question that medical school is stressful, full of feedback (both positive and negative), and is physically and emotionally demanding. Research suggests that medical school may even "produce stress at levels which are hazardous to the physical and psychological wellbeing of students" (Lee & Graham, 2001, p. 652). Although moderate levels of stress and negative feedback are to be expected, as these elements can promote creativity and motivate a student, students who repeatedly underperform, in conjunction with receiving negative feedback, are more likely to ultimately fail or grow into incompetent doctors (Challis, Fleet & Batstone, 1999; Papadakis, Teherani, & Banach, 2005; Cleland, Knight, Rees, Tracey, & Bond, 2008). Too many of the "pressures and relentless demands of medical education may impair student behavior, diminish learning, destroy personal relationships, and ultimately affect patient care" (Wolf, Elaston, & Kissling, 1989; Lee & Graham, 2001, p. 652).

Supporting Dweck and Grant's (2008) findings, this study found that one's ITI impacted the way in which participants reacted to setbacks and challenges. Those with an incremental theory of intelligence reported feeling fewer negative emotions overall while reacting to difficulties in learning; while entity theorists reported feeling more vulnerable and anxious as they struggled and progressed through the course.

Although the exact nature of the relationship between medical student grit, ITI, and achieving one's goals is still unclear, findings from this study do suggest a likely relationship between the grit level, the reactions, and the outcomes an individual has while learning gross anatomy. Namely, the grittier the individual, the better the coping mechanisms they demonstrate, and the better they perform in gross anatomy. In addition, findings from this study indicate there are individuals with certain ITI and grit characteristics who are particularly susceptible to stressful, challenging environments. Therefore, more research is needed in order to address the question of how to set up a system that not only rewards for hard work and performance and those who seek after learning goals, but supports those at increased susceptibility.

Themes in Goal Monitoring

When it comes to monitoring one's goals, specific focus in this study was placed on understanding themes related to the emotions medical students felt as they progressed through their gross anatomy experience. In the literature it has been shown that entity theorists believe, for the most part, that intelligence is fixed, and even though new things can be learned, they either have the raw ability to do something or they do not (Duckworth et al., 2007). In general, when it comes to evaluating their potential for goal success, entity theorists report more negative emotions, feelings of vulnerability, and anxiousness when it comes to monitoring their performance—good or bad (Duckworth et al., 2007). Conversely, incremental theorists and grittier individuals believe that hard work will lead to an evolving, increased intelligence; often reporting greater confidence and optimistic expectations when it comes to monitoring their potential for goal success (Dweck, 2000).

The findings from this study support and expound on the aforementioned literature in two major ways. First, an individual's ITI, more so than grit level, appeared to determine *if* there were negative emotional reactions from a medical student. That is, those with an entity ITI overwhelmingly reported feeling vulnerable and anxious as they monitored their progress in the course, while those with an incremental ITI had much fewer negative emotions that accompanied the monitoring of their personal progress in gross anatomy. Second there was a weak, albeit significant, positive association between grit and being an incremental theorist—meaning that the higher your grit level, the more likely it was that you were an incremental theorist. More importantly though, it emerged that grit level was key in moderating *how* a medical student would respond to the negative emotions they felt. Specifically, when compared to low grit individuals, high grit individuals exhibited more effective coping mechanisms to the anxiety and vulnerability they felt by responding with hard work, developing new study habits, and allowing one's self to have confusion and work through it.

Although medical schools take great care in selecting their applicants for admission by identifying intelligent, philanthropic individuals with a strong commitment to their goals of becoming a physician, the process of completing medical school is a rigorous one, even for the best-qualified candidate. Research has shown that the "current educational process may have an inadvertent negative effect on students' mental health, with a high frequency of depression, anxiety, and stress among medical students" (Guthrie et al., 1995; Guthrie et al., 1998; Aktekin et al., 2001; Moffat, McConnachie, Ross, & Morrison, 2004; Dyrbye, Thomas, & Shanafelt, 2006, p. 354). Some have even suggested that psychological distresses among students may adversely impact their academic performance (Spiegel, Smolen, & Hopfensperger, 1986; Spiegel, Smolen, Jonas, 1986; Stewart, Lam, Betson, Wong, & Wong, 1999), with the Association of American Medical Colleges (AAMC) calling for the medical education system to take into account the health and well-being of learners (Association of American Medical Colleges, 2004). Understanding this, it becomes that much more pertinent to consider how those non-academic characteristics, like ITI and grit, can illuminate and better predict the complex emotions medical students may feel as they progress through gross anatomy and the medical school experience. In turn, knowing these characteristics would allow proper and proactive intervention to provide extra emotional support and or resources to those who need it most.

Implications for Practice and Suggestions for Future Research

How educators use their influence in the classroom can determine important outcomes for students in terms of how they will approach and experience their learning in the present and the future (White, 2006). Although the influence of the educator in the classroom was not examined in this study, findings in this study have the ability to inform educators in the gross anatomy classroom. Knowledge of students' ITI and grit levels can provide a more holistic understanding of classroom dynamics and the non-academic factors that drive, motivate, impede, and even influence learning actions. For example, although incremental theorists, especially those with high grit, are not the only medical students who succeed in anatomy, findings from this study suggest that there are advantages in the way this student group approaches, reacts, and navigates the learning process. This is especially true as highly gritty incremental theorists are an intrinsically motivated group. They are largely self-motivated individuals who set goals that reflect a deeper want of understanding and application; they consistently embrace challenges and see negative feedback as something to learn from, and respond to, with hard work and optimism. As intrinsically motivated students, they look beyond “assignments and delve deeper into material to understand concepts and structures,” seeking after knowledge that is associated with “deep learning…higher order cognition, including analysis, synthesis, and evaluation” (White, 2006, p. 281). For this reason, a longitudinal or interventional study may provide a more comprehensive understanding of how grit in our medical students can more purposefully be cultivated, supported, developed, and rewarded in the classroom.

In addition, while interventional studies teaching an incremental theory point of view to adolescents have shown to promote positive changes in classroom motivation and improvement in performance, we do not know if these interventions would work in the medical school setting (Blackwell et al., 2007). Further research is needed to determine if by the time a student reaches medical school we still have the ability to influence their ITI or grit. However, research does indicate that educators and faculty “may be in a position to create an environment where a growth mindset and grit are fostered,” through helping students to internalize the motivation to persist (Hochanadel & Finamore, 2015, p. 49). Duckworth et al. (2007) even showed that a more incremental theory of intelligence could be cultivated, albeit in young students, to produce a growth mindset that in turn could develop the grit of an individual.

Many medical schools, IUSM included, have placed great importance on developing the skills of self-regulated learning in their students; skills vital for lifelong learning in medical practice (Lowenthal, 1981; Sullivan, Hitchcock, & Dunnington, 1999; White, 2006). However, medical schools tend to make assumptions that students will automatically engage in self-driven lifelong learning after graduation and into residency (White & Fantone, 2010). This does not always happen though, for students know that certain performance oriented achievements, for example grades, are rewarded more heavily than lifelong learning goals. As such, grades often become the focus, even the obsession of students, with many agreeing, "grades are important, especially if you have any hope for getting the more prestigious fellowships and coveted learning opportunities" (HE2, p. 1). The reality is that better grades in medical school are generally rewarded with better residency placements and opportunities for research experience (Provan, 1995; Gonella, 2004). This then becomes especially discouraging, as research has shown that a focus on testing at many universities can undermine both creativity and grit (Dweck, 2000; Hochanadel & Finamore, 2015).

However, there are a number of medical schools that are now "eliminating a cornerstone of extrinsic motivation: discriminating grades" (White & Fantone, 2010, p. 469). Switching from a discriminating grades scale (honors, high pass, pass, and fail), to a pass-fail grading scale has been shown to: reduce competition, equalize the playing field for students coming in with various backgrounds, increase collaboration between students, and most importantly foster intrinsic motivation—a fostering that could prove to be incredibly advantageous, as findings from this study indicate that not all of our medical students have high grit or consistent internal motivation to work hard (White &

Gruppen, 2007). It is important to note that no statistically significant changes in exam averages, USMLE Step 1 scores, or residency placements have typically been seen after a change to a pass-fail system in medical schools (Scoles, 2008; White & Fatone, 2010).

Many medical school programs support learning approaches that encourage intrinsic motivation for learning tasks, student participation in decision-making tasks, and environments where feelings about learning are discussed openly "so the positive feelings can be reinforced through pedagogy and feedback, and negative feelings can be reflected upon and addressed," however, this is not universal (Boud, 1998; Candy, 1998; Kersson-Grip, Hess, & Trees, 2003; White, 2006, p. 280). Although switching to a pass-fail system is a start, many schools have yet to comprehensively integrate formal programs into their curricula to promote or enhance self-regulated learning skills (White, 2006). Findings from this study confirm there are medical students who do not self-regulate as effectively as others. Certain participants, including HE, LI, and LE students, are often more extrinsically motivated and characterized by needing positive feedback, reacting inconsistently to challenges, and hoping to achieve a specific grade or outcome that is externally controlled—like passing a test, or getting an honors grade. Research has shown that extrinsic motivation "has been linked to surface learning" which is characterized by lower order cognition activities like memorization (Entwistle & Ramsden, 1983; White, 2006, p. 281). Thus, there is additional reason to measure the ITI and grit of our medical students. Being aware of how one self-regulates their learning processes has the potential to foster a deeper awareness of the material learned and encourages more constructive coping mechanisms.

Furthermore, it could be argued that individuals with an entity theory of intelligence or with lower levels of grit could benefit from educators in their classrooms who are more explicitly aware of the way in which they view intelligence and their level of grittiness. Educators thus equipped could more overtly and explicitly help to set goals and more closely monitor how students are accomplishing them. In addition, educators could consider constructing a learning environment that places less importance and reward on performance oriented goals, and more on learning goals. One possibility would be to implement in gross anatomy a pass-fail grading system; a grading system that could potentially minimize the extrinsic rewards for the majority of students who are motivated by performance goals in the first place.

Refreshingly, general instructional design at the medical school level has begun to focus more intently on emphasizing the mastery of content in order to apply it, which is a much greater challenge than simply covering content (Sibley & Parmelee, 2008). This requires a transformation and new approach to designing courses and to teaching. When the overarching goal becomes significant learning, learning that endures well past the end of the course, it increases the responsibility of the educator (Fink, 2003). The educator must consider the design of assessments and orchestrate learning activities that enable students to first master the knowledge and then apply it to increasingly complex problems (Sibley & Parmelee, 2008). If an educator has knowledge of their students' ITI and grit, they will be more aware of the proclivity of certain students to react negatively to challenging learning activities, can more effectively guide low grit students to avoid being overwhelmed by challenges, help students determine where to put their efforts in order to persist in the face of academic challenges, reward consistency in work ethic, and better foster an environment in which students feel safe to struggle, be confused, and have the space and time in which to work through confusion.

Limitations

Although every attempt was made to minimize confounding factors and other potential sources of bias, the researcher acknowledges that this study was limited by several factors, and as such, are important to highlight. First, this study was only conducted at one school, Indiana University School of Medicine, and thus represents a limited sample population. Therefore, these findings may not be generalizable to students at other institutions. Second, only 43% of medical students responded to the survey; a higher response rate would be advantageous. Third, this study was not longitudinal in nature; meaning, students' ITI and grit levels were not measured for changes throughout their time in medical school. Therefore, important evolutions in ones' ITI or grit over the course of medical school could impact findings. Fourth, the researcher's personal experiences and biases as an anatomy educator, and the fact that the research was conducted at her home institution, can be a limitation because this may create biases or influence the participants (Patton, 2002). However, necessary steps were taken to minimize these biases through maintaining a rigorous research protocol, continually reflecting on the data, and disclosing personal biases to participants.

Conclusion

The causes of academic failure in undergraduate medical education, including gross anatomy, are diverse and often not academic in origin. Research indicates that issues related to financial, home life, and emotional matters are all contributing factors (Sayer, Chaput De Saintonge, Evans, & Wood, 2002). In addition, the literature identifies nearly 90 different personal attributes and qualities that are relevant to the effective practice of medicine (Albanese, Snow, Skochelak, Huggett, & Farrell, 2003). However, deciding which of these are most relevant and can practically and reliably be measured in our medical students is a daunting task. Although few argue that there is a need for better personal quality measures of our medical students, personal qualities must be measured in a cost-effective, reliable manner and measured with tools that have the validity and strength to outmaneuver those individuals with the motivation and ingenuity to invalidate such measures (Albanese et al., 2003). The question is how to do this.

Findings in this study indicate that one's ITI and grit are good measures that reveal numerous personal qualities and attributes that influence learning and impact the self-regulatory processes medical students use in learning gross anatomy. Specifically, in this study, major findings were:

1. There was a statistically significant difference in the mean raw grit scores between those who scored in the high grade group (88-100%) and those who scored in the low grade group (70-87%) in gross anatomy.
2. There was a moderate, positive, statistically significant relationship between grit and grade percentage in gross anatomy.
3. There was a weak, positive, but statistically significant relationship between ITI and grit—the grittier an individual, the more likely they were an incremental theorist.
4. Only entity theorists expressed as their ultimate goal the desire to attain an honors grade, finding themselves pandering to succeed on the exam and placing getting an honors grade as a central goal for the course.

5. All participants whose ultimate goal was to understand and apply their anatomical knowledge were highly gritty and had an incremental view of intelligence.
6. Participants whose ultimate goal was to perform at the course average all had low grit and often aimed for an average performance.
7. Participants from all categories (HE, HI, LE, and LI) voiced their concerns and regrets over having had to sacrifice long-term learning for the sake of getting a particular grade during medical school.
8. HE medical students often questioned if they truly deserved to be in medical school and doubted their own intellectual abilities. This group typically responded with working harder and aiming for a better grade outcome in the course.
9. HI medical students saw failure and negative feedback as an opportunity from which to learn; feedback that didn't lead to questioning of self-worth, but rather pushed students to become better physicians for future patients.
10. LE students really struggled through challenges. Due to an inconsistent work ethic, these students often became overwhelmed and questioned if they were smart enough to practice medicine.
11. LI students yearned to learn concepts well for their future patients, but struggled with mastering the material and maintaining consistent effort.
12. An individual's ITI, more so than grit level, appeared to drive the presence or absence of negative emotions in a medical student. Those with an entity ITI overwhelmingly reported feeling vulnerable and anxious as they

monitored their progress in the course, while those with an incremental ITI had much fewer negative emotions that accompanied the monitoring of their personal progress in gross anatomy.

13. Grit level was key in moderating how a medical student would respond to the negative emotions they felt. Specifically, when compared to low grit individuals, high grit individuals exhibited more effective coping mechanisms to the anxiety and vulnerability they felt.

Although academic variables such as grade-point averages (GPAs) and Medical College Admission Test (MCAT) scores are the primary means of selecting medical students for admission, many studies have begun to point to the same conclusions in the field of medicine as drawn here; that is, non-academic factors may be more important than previously recognized (Naylor et al., 2008; Burkhart et al., 2014). Perhaps our dedication and current focus in the literature on understanding the different learning styles, strategies, and instructional methods in the anatomy classroom are actually secondary to the level of grit that each student brings to the classroom. Conceivably measuring, attending to, and encouraging grit in the classroom, while recognizing ITI, within a pass-fail grading system could be the "new approach…needed and required to change the situation" we find ourselves in (Small et al., 1993, p. S96); a situation that takes into account very few of the non-academic factors that drive learning, that overemphasizes rote learning, and that fosters little meaningful learning.

Keeping these findings in mind, it becomes clear why measuring the ITI and grit of our medical students could be advantageous and, perhaps one day, be used as a new standard to measure important personal attributes that deeply impact the medical student learner. A measuring that has just started to be done at universities and graduate admissions programs around the country. Programs like Fisk-Vanderbilt University seek out students who exemplify quantifiable grit, and the interview protocol has been adapted to rank certain interviewee responses on a grit scale for selection (Powell, 2013). However, there is a need to conduct additional studies and further research in this field; preferably done at other universities with additional medical students from different curricula. Although the implicit theories of intelligence scale and the short grit scale instrument have the potential to be used to assess individual characteristics, they could go further by providing a more dynamic integrated approach to medical school admission assessment and serve as helpful tools in the ever changing anatomy classroom. There is insight in knowing the ITI and grit of an individual; two numbers that become tools to the educator and learner who know them. Tools that provide understanding of how a student might work through frustrations, better respond to setbacks, and ultimately find comfort with the ambiguity that is medicine and clinical problem solving.

When speaking with a medical student who had high grit and an incremental theory of intelligence, I asked him how one can succeed in medical school, and he responded without a moment's hesitation: "Discipline, hard work, and planned strategy…you have those qualities in medicine and you can conquer anything" (HI1, p. 10). I could not agree more with this statement, and as I look back upon my own educational experiences and lessons learned while a student, a clear pattern for success has emerged. A pattern that has always come down to how much I was willing to work, how dedicated I was to the work, and how I attempted to navigate through that work; those elements are what made the real lasting difference. In understanding the ideas of grit and implicit theories of intelligence, we have the opportunity as educators to teach students how to persist, promote effective coping mechanisms, and encourage students to remember their long-term goals. In doing so, our future physicians will be better equipped to overcome the unique challenges they will undoubtedly face while practicing medicine in the 21st century.

Appendix A: Dweck's Implicit Theories of Intelligence Scale (ITIS)

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

1. ______You have a certain amount of intelligence, and you can't really do much to change it.
2. ______Your intelligence is something about you that you can't change very much.
3. ______No matter who you are, you can significantly change your intelligence level.
4. ______To be honest, you can't really change how intelligent you are.
5. ______You can always substantially change how intelligent you are.
6. ______You can learn new things, but you can't really change your basic intelligence.
7. ______No matter how much intelligence you have, you can always change it quite a bit.
8. ______You can change even your basic intelligence level considerably.

Appendix B: Short Grit Scale

1. New ideas and projects sometimes distract me from previous ones.
    a. Very much like me
    b. Mostly like me
    c. Somewhat like me
    d. Not much like me
    e. Not like me at all

2. Setbacks don't discourage me.
    a. Very much like me
    b. Mostly like me
    c. Somewhat like me
    d. Not much like me
    e. Not like me at all

3. I have been obsessed with a certain project for a short time but later lost interest.
    a. Very much like me
    b. Mostly like me
    c. Somewhat like me
    d. Not much like me
    e. Not like me at all

4. I am a hard worker.
    a. Very much like me
    b. Mostly like me
    c. Somewhat like me
    d. Not much like me
    e. Not like me at all

5. I often set a goal but later choose to pursue a different one.
    a. Very much like me
    b. Mostly like me
    c. Somewhat like me
    d. Not much like me
    e. Not like me at all

6. I have difficulty maintaining my focus on projects that take more than a few months to complete.

   a. Very much like me
   b. Mostly like me
   c. Somewhat like me
   d. Not much like me
   e. Not like me at all

7. I finish whatever I begin.

   a. Very much like me
   b. Mostly like me
   c. Somewhat like me
   d. Not much like me
   e. Not like me at all

8. I am diligent.

   a. Very much like me
   b. Mostly like me
   c. Somewhat like me
   d. Not much like me
   e. Not like me at all

Scoring:

1. For the "High-Grit" questions 2,4,7 and 8 the following points are assigned:
   5 = Very much like me
   4 = Mostly like me
   3 = Somewhat like me
   2 = Not much like me
   1 = Not like me at all

2. For the "Low-Grit" questions 1,3,5 and 6 the following points are assigned:
   1 = Very much like me
   2 = Mostly like me
   3 = Somewhat like me
   4 = Not much like me
   5 = Not like me at all

Appendix C: Interview Guide

General questions:

1. How would you say you did in Gross Anatomy?
2. What was your favorite thing about the course?
3. What was your least favorite thing about the course?
4. What type of learning strategies did you employ/use in learning gross anatomy that you felt were most advantageous?
    a. Disadvantageous?

Goal Setting Questions:

1. Can you recount one of the goals that you set for yourself when you took gross anatomy as a course?
    a. Why was that an important goal to you?
2. If you had to choose between getting an Honors grade and knowing the material only fairly well, versus getting a Pass grade, but knowing the material really well. Which would you choose?
    a. Why?
    b. Do you feel that you have ever had to sacrifice long-term learning for the sake of getting a particular grade? Or because time has been too limited?

Goal Operating Questions:

1. Think back to a difficulty, obstacle, or a challenging experience you had when learning anatomy, could you describe that experience?
    a. Specifically, how do you remember feeling when you had that particular setback?
    b. Do you feel that that was a normal reaction for you to a difficult situation?
    c. As you went through the anatomy course, and subsequent courses in medical school, do you feel that your reaction to difficulties/or challenges have remained the same, or have you seen a change in yourself?
2. Now, if you can, think back to particular experiences in medical school (might have been in anatomy, might not have been), where you failed. Doesn't have to be failing a test—it could be failing in any sense.
    a. How did that make you feel?
    b. Did you give up on that particular goal, and switch to another?
3. Have you ever received blatantly negative feedback on what you did in anatomy?
    a. Do you agree with the fact that it deserved that feedback?
    b. Did it make you question your inherent intellectual ability as an individual?

Goal Monitoring Questions:

1. When you found yourself facing a challenge or difficulty when trying to learn anatomy, did you have any fears, or anxiousness?
    a. How did you face those fears?
    b. Were there any particular resources you pulled upon that helped?
2. Think back to a time in gross anatomy where you felt you succeeded/did well. Could be a big or small success. What do you think led to that success?
    a. Do you feel that raw intellectual ability played a role? How much?
3. When monitoring your progress throughout the semester as gross anatomy proceeded if you had to choose one of the following categories of feelings that best encapsulate how you felt as you monitored your progress, what would it be?
    a. Vulnerable/anxious
    b. Confident/optimistic

<u>Final Questions:</u>

1. Do you think that anybody can succeed in gross anatomy if they just work harder?

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Yin, R. (2012). *Applications of case study research* (3rd Ed.). Thousand Oaks, CA: SAGE Publications, Inc.

CURRICULUM VITAE
Erin Paige Fillmore

EDUCATION

Doctor of Philosophy: Anatomy and Cell Biology May, 2015
Minor: Education
Indiana University
Indianapolis, Indiana
Dissertation Title: Grit and Beliefs About Intelligence: The Relationship and Role These Factors Play in the Self-Regulatory Processes Involved in Medical Students Learning Gross Anatomy

Masters of Public Health: Occupational and Environmental Science 2010
University of Iowa
Iowa City, Iowa

Bachelor of Arts: History 2005
Brigham Young University
Provo, Utah

TEACHING EXPERIENCE

Indiana University School of Dentistry 2014-2015
Systems Approach to the Biomedical Sciences Course Lecturer and Module Director
- Module director for Nerve/Neuromuscular Anatomy.
- Course lecturer in nerve/neuromuscular anatomy, respiratory anatomy, musculoskeletal anatomy, cardiovascular anatomy.
- Course lecturer in nerve/neuromuscular embryology, respiratory embryology, musculoskeletal embryology, cardiovascular embryology.
- Responsible for formative and summative assessments.

Indiana University School of Medicine
Medical Gross Anatomy Lecturer, Teaching Assistant, and Laboratory Tutor 2013-2014
- Course Lecturer.
- Responsible for laboratory instruction, and preparing prosected cadaveric specimens.
- Mentored small student dissection groups in the gross anatomy laboratory in the head and neck unit, and assisted students in designing personalized learning strategies.
- Aided in setting up and conducting practical exams.

Medical Neuroscience and Clinical Neuroanatomy Teaching Assistant: 2012-2014
- Instructed and assisted medical, graduate and physical therapy students in the neuroanatomy wet laboratory.

- Prepared and presented original lecture series on the somatosensory system.
- Designed interactive online brainstem and forebrain modules for medical, graduate and physical therapy students to utilize as self-assessment learning tools.
- Tutored individual students and conducted exam reviews.

Functionally-Oriented Human Gross Anatomy Teaching Assistant: 2012-2014

- Responsible for laboratory instruction, preparing prosected cadaveric specimens, and instructor guided structure identification.
- Prepared and presented original lecture series on the pectoral region, breast, axilla, brachial plexus, arm, forearm and hand.
- Mentored small student dissection groups in the gross anatomy laboratory and helped students design personalized learning strategies.
- Aided in setting up and conducting practical exams.

Graduate Neuroanatomy Teaching Assistant: 2012

- Developed original series of neuroscience lectures related to the brainstem, integrating relevant clinical correlations into student problem sets and atlas neuroanatomy exercises.
- Tutored individual students and assisted in the administration of exams.

Graduate Histology Teaching Assistant: 2011

- Designed and conducted a Team Based Learning (TBL) module for graduate and pathology assistant students.
- Teaching responsibilities included lecturing on eye histology, ear histology, and relevant clinical concepts.
- Assisted in laboratory instruction, exam review and individual student tutoring.

Marion University College of Osteopathic Medicine

Essential Clinical Anatomy and Development Laboratory Instructor 2014

- Laboratory instructor and tutor.
- Aided in setting up and conducting practical exams.

Indiana University Purdue University Indianapolis

Human Anatomy Laboratory Instructor in the Department of Biology 2011-2014

- Designed and presented original series of lectures for instruction in the laboratory component of the course.
- Directed laboratory discussion groups, individual student tutoring sessions and exam reviews.
- Wrote and administered practical exams.

University of Iowa

Principles of Human Anatomy Teaching Assistant 2009-2010

- Co-instructor for undergraduate level course in anatomical terminology, cell structure, histology, and organ systems of the human body.
- Assisted course director in integrating relevant clinical correlations into course curriculum and review sessions.

Contemporary Environmental Issues Teaching Assistant: 2008-2010

- Designed course specific quantitative teaching evaluation survey.
- Lectured on alternative energy, global climate change, Kuznets Curve theory, biodiversity loss, and genetic engineering.
- Directed and led undergraduate laboratory discussion sessions, graded research papers and exams.

PROFESSIONAL ORGANIZATIONS

Human Anatomy and Physiology Society (HAPS)	2013-Present
International Association of Medical Science Educators (IAMSE)	2012-Present
American Association of Clinical Anatomists (AACA)	2011-Present
American Association of Anatomists (AAA)	2011-Present

POSTERS/PRESENTATIONS AT PROFESSIONAL MEETINGS

American Association of Anatomists (AAA) Student/Postdoctoral Educational Research Poster Award Finalist

- March, 2015
- Evolutionary Biology Meeting in Boston, MA
- Title of Poster: *Medical Student Grit and Performance in Gross Anatomy: What are the Relationships?*

American Association of Clinical Anatomists (AACA): Platform Presenter

- July, 2014
- Title of Presentation: *Anatomical Preparation for Competence: Perceptions of Fourth Year Medical Students and Residents*

Presenter at the IU School of Medicine Anatomy and Cell Biology Department Seminar

- June, 2014
- Title of Presentation: *Understanding the Current Anatomical Competence Landscape: Perceptions of Fourth Year Medical Students, Residents and Programs Directors at Indiana University*

American Association of Anatomists (AAA) Educational Research Platform Presentation Finalist, and First Place Winner

- April, 2014
- Evolutionary Biology Meeting in San Diego, CA
- Title of Presentation: *Understanding Anatomical Competence: Perceptions of Residents and Program Directors Using a Mixed Methods Survey*

American Association of Anatomists (AAA): Platform Presenter

- April, 2013
- Evolutionary Biology Meeting in Boston, MA:
- Title of Presentation: *Exploring two different gross anatomy laboratory experiences: The perspective of the repeating first year medical student*

Participant in the Department of Anatomy Fall Research Symposium

- 2012
- Poster Presentation: *Exploring Two Different Gross Anatomy Laboratory Experiences: The Perspective of the Repeating First Year Medical Student.*

Co-Presenter at the IU School of Medicine Anatomy and Cell Biology Department Seminar

- May, 2012
- Lectured with Dr. Robert Helfenbein, PhD (Associate Professor of Curriculum Studies at IUPUI)
- Title of Presentation: *Translational Research in Medical Education*

<u>PUBLICATIONS</u>

Indiana University School of Medicine

- **Fillmore, E.**, Helfenbein, R., Seifert, M. (2014). *Dissecting anatomy: Exploring the perspective of the repeating first year medical student in both an open and peer teaching gross anatomy laboratory format*. Medical Science Educator. July, DOI 10.1007/s40670-014-0058-6.
- **Fillmore, E.**, Brokaw, J., Kochhar, K., Nalin, P. (2014). *Anatomical preparation for competence: perceptions of fourth year medical students and residents*. Clinical Anatomy, 27: 1304-1329.
- **Fillmore, E.** (2013). *Clicking to Clinical Discovery: Embedding clickers in an undergraduate introductory anatomy course*. Clinical Anatomy, 26: 1036-1062.

Publications In Press:

- **Fillmore, E.**, Seifert, M. *The Detailed Anatomy of the Trigeminal Nerve.* In R. Shane Tubbs, Elias Rizk, Mohammadali Shoja, Marios Loukas, Mayo Foundation for Medical Education Research ("Mayo"), Robert J. Spinner & Nicholas Barbaro (Eds.), Nerves and Nerve Injuries (in press).
- **Fillmore, E.**, Brokaw, J., Kochhar, K., Nalin, P. *Understanding anatomical competence: perceptions of residents and program directors using a mixed methods survey*. FASEB Journal. April 2014 (in press).

Submitted:

- **Fillmore, E.**, Brokaw, J., Kochhar, K., Nalin, P. (2014). *Understanding the current anatomical landscape: comparing perceptions of program directors, residents, and fourth year medical students*. Anatomical Sciences Education.

Current Research in Progress:

- *Junior Surgeons: Perceptions of Anatomical Knowledge* (Surgical Review Course, Co-Author Dr. Ali Mirjalili: University of Otago)
- *Improving the Anatomical Competence of Our Medical Residents: The Insights of Program Directors* (Indianapolis School of Medicine)
- *Examining the Opinions of Residents: How Can Anatomical Competence Be Improved?* (Indianapolis School of Medicine)

University of Iowa

- Ramirez, M., **Fillmore, E**., Chen, A., Peek-Asa, C. A Comparison of School Injuries between Children with and without Disabilities. *Academic Pediatrics*, September-October 2010, Vol. 10 (5).
- **Fillmore, E.**, Ramirez, M., Roth, L., Robertson, M., Atchison, C., Peek-Asa, C. After the Waters Receded: A Qualitative Study of University Official's Disaster Experiences During the Great Iowa Flood of 2008. *Journal of Community Health,* September 2010.

OTHER EDUCATIONAL AND SERVICE ACTIVITIES

Presidential Appointee to the AACA Educational Affairs Committee

- 2014-2016
- Committee member

Reviewer for the Journal of Biomedical Education

- 2014

IAMSE 2014 Review Committee Member

- 2013-2014

Academy of Teaching Scholars:

- 2011 to Present
- Member of the Academy: Tier One Completed

Indiana University School of Medicine: Educational Consultant for Curricular Reform Team

- 2011-2012
- Member of the Life Long Learning Curricular Reform Committee.
- Volunteer educational consultant for Indiana University's planning team charged with redesigning the Life Long Learning competency as part of a medical school-wide curriculum reform effort.

Mentor for Indiana University School of Medicine: Educational Outreach Program

- 2012-2013
- Member of the Howard Hughes Medical Institute Pre-College Program at Crispus Attucks Medical Magnet High School.
- Responsible for weekly tutoring of high school students in the biological, anatomical, physical and chemical sciences.